RED RIVER AQUATIC BIOLOGICAL MONITORING

1999

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ECOLOGICAL

CONSULTANTS, INC.

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Prepared for:

MOLYCORP, INC.
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TABLE OF CONTENTS

INTRODUCTION

The New Mexico Environment Department (NMED) conducted a Total Maximum Daily Load (TMDL) study of the Red River in 1999. During development of the study, agreement was reached between NMED, the New Mexico Department of Game and Fish (NMDGF), and Molycorp that Molycorp would be responsible for collecting data on aquatic biological parameters for the TMDL study. The agencies and Molycorp agreed that Chadwick Ecological Consultants, Inc. (CEC) would be responsible for collecting data on fish and benthic invertebrate populations, aquatic habitat, and stream bottom sediment at twelve sites along the length of the Red River. This information addresses the needs of the TMDL study as well as ongoing annual monitoring of fish and invertebrate populations initiated by Molycorp in 1997 (CEC 1998).

Monitoring was initiated in 1997 to evaluate the effects of open pit mining operations and waste rock dumps on aquatic biota (i.e., fish and benthic invertebrate populations) in the Red River upstream, adjacent to, and downstream of the Questa Molybdenum Mine over a 30-year period (CEC 1997, 1998). The initial study included an analysis of historical information in addition to field sampling efforts (CEC 1997). The conclusions from the first year of the study (1997) indicated that observed negative impacts to fish and benthic invertebrates in the Red River were caused primarily by naturally occurring thermal scars downstream from the town of Red River, especially downstream of Hansen Creek. This pattern was evident during baseline (pre-1966) conditions and present (1995-1998) conditions. The open pit mine and waste rock piles did not appear to have measurably impacted the suitability of the Red River to support aquatic organisms.

Our original report (CEC 1997) discussed the approach and scope of our evaluation in detail. That analysis is not repeated here. The purpose of this report is to present aquatic habitat, fish and benthic invertebrate population, and sediment monitoring data collected in 1999 for the TMDL study and to further evaluate the trends identified in previous monitoring reports (CEC 1997, 1998, 1999). The most recent data are used to further assess the potential impact of open pit mining and waste rock piles on fish and benthic invertebrate populations of the Red River.

The Questa Molybdenum Mine began operations in 1919, using underground mining methods (Schilling 1990). Late in 1965, the mine initiated open pit mining operations that continued until 1983 (Slifer

1996). Tailings from the mill are piped down the valley to tailings ponds near the town of Questa (Fig. 1). Waste rock was deposited near the open pit on Molycorp property in areas which drain Spring Gulch, Sulphur Gulch, Goathill Gulch, and Capulin Canyon (Fig. 1).

In order to evaluate long-term trends in aquatic biological data, the historical information has been divided into three time periods: baseline (prior to open pit mining), open pit and underground mine operation, and present conditions (CEC 1997). Baseline conditions refer to the period prior to 1966. This includes fish data collected in 1960 by NMDGF (1960) and benthic invertebrate data collected in 1965 by the U.S. Department of Health, Education, and Welfare [USDHEW] (1966). During the period of open pit and underground mine operation, benthic invertebrate data were collected in 1970-1992, and fish data were collected in 1974-1988 (CEC 1997).

Present conditions refer to the benthic invertebrate data collected in 1997, 1998, and 1999 by CEC and data collected in December 1995 by NMED and analyzed by Woodward-Clyde (1996). Present conditions for fish include data collected in 1997, 1998, and 1999 by CEC, as well as data collected in August 1997 by NMDGF. A detailed listing of all available data for baseline conditions, historic conditions in the intervening years of mine operation (data collected 1970-1992), and present conditions (through fall 1998) is contained in our previous reports (CEC 1997, 1998, 1999).

STUDY AREA

The study area includes the Red River from its headwaters to the confluence with the Rio Grande. The Molycorp Questa Molybdenum Mine is adjacent to the north bank of the Red River in its middle reaches, between the towns of Red River and Questa (Fig. 1).

Reach Descriptions

In order to organize the available historical fish and benthic invertebrate data in our previous report (CEC 1997), we segmented the Red River into six reaches (Fig. 1). These reaches are used to group data from multiple historical sampling sites into distinct, biologically significant parts of the river which contain roughly

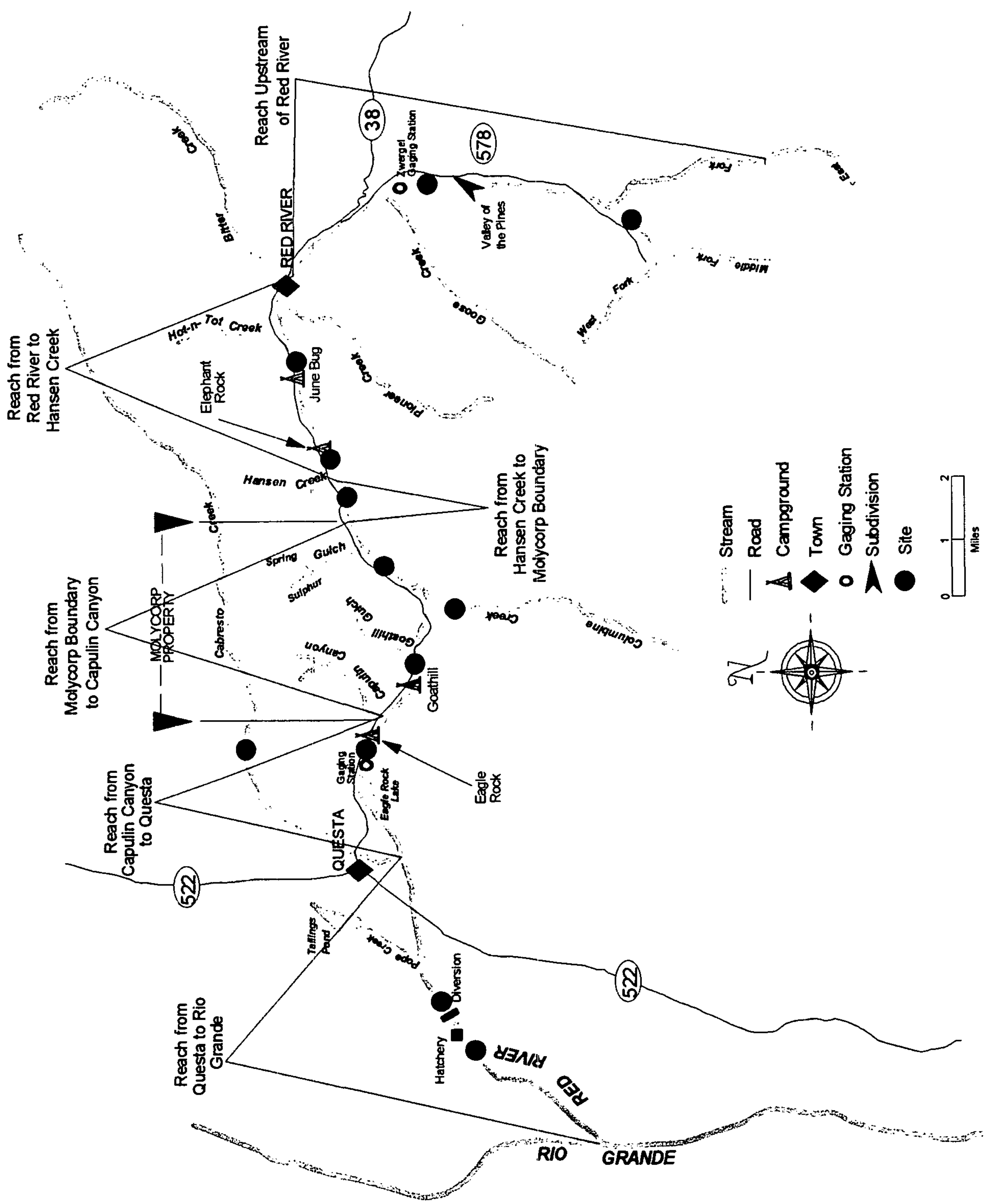

FIGURE 1: Red River study area with six river reaches and Chadwick Ecological Consultants, Inc. 1997-1999 aquatic habitat, fish, benthic invertebrate, and sediment sampling sites.

similar characteristics of channel morphology, habitat, potential impacts, etc. This allowed a more focused interpretation of the historical data. These same six reaches are also used to organize the monitoring data collected during 1997-1999. Summarized descriptions of the six reaches are presented below. More detailed descriptions were presented in our previous report (CEC 1997).

Upstream of Red River

This reach of the Red River includes its headwaters downstream to just upstream of the town of Red River. There is some residential development in this portion of the river, in the form of vacation homes (e.g., Valley of the Pines subdivision) and commercial lodges, but not to the extent present in the town of Red River. The substrate in this reach exhibited little accumulation of silt and sand, with low embeddedness. This reach provides good habitat for the different age classes of trout.

Red River to Hansen Creek

This reach extends from the town of Red River to just upstream of the confluence with Hansen Creek. Bitter Creek flows into the Red River at the town of Red River. It contains historical mining operations and natural hydrothermal scars, which apparently contribute sediment to the Red River. Potential impacts to this reach include channelization, erosion from the highway, outfall of the town of Red River's wastewater treatment plant, and runoff from natural hydrothermal scars drained by Bitter Creek and Hot-n-Tot Creek.

Hansen Creek to Molycorp Boundary

This reach extends from the confluence with Hansen Creek downstream to the eastern edge of the Molycorp property boundary. The major characteristic of this reach is the inflow of Hansen Creek, which drains a large area of hydrothermal scarring. Runoff from this scarring carries sediment into the Red River, creating a relatively large alluvial fan, as well as lower pH waters.

In addition to inputs from Hansen Creek, Hansen Spring also apparently introduces substances to the Red River in this reach. This spring is located in an overflow channel adjacent to the Red River, and appeared to input directly into the Red River. Its channel contained a very evident white precipitate.

Molycorp Boundary to Capulin Canyon

Extending from the eastern Molycorp property boundary downstream to just upstream of the confluence with Capulin Canyon, this reach contains the confluence with Columbine Creek, which joins the Red River from the south side of the valley. Columbine Creek is a small, clear stream that apparently acts to dilute the Red River.

Capulin Canyon to Questa

This reach extends from the confluence with Capulin Canyon downstream to just upstream of the confluence with Cabresto Creek, near the town of Questa. As with the reach from Hansen Creek to the Molycorp eastern property boundary, a major feature in this reach is a natural hydrothermal scar; in this case, the one drained by Capulin Canyon. Capulin Springs also enter the Red River in this reach. These seeps apparently introduce substances to the Red River, including those producing a white precipitate.

Questa to Rio Grande

This reach extends from the confluence with Cabresto Creek, near the town of Questa, downstream to the confluence of the Red River and the Rio Grande. At the upper end of this reach, Cabresto Creek adds clear, diluting flows to the Red River. The river valley widens at Questa, and portions of this reach through Questa have areas of unstable stream banks, which contribute to more shallow average water depths compared to downstream portions of this reach. The river valley subsequently narrows again upstream of the state fish hatchery, and remains a narrow canyon down to the Rio Grande.

In addition to the ten sites previously monitored in 1997 and 1998, two additional sites were sampled in 1999 in conjunction with the NMED TMDL study. One site was located on the Middle Fork of the Red

River, in the reach upstream from the town of Red River. The second site was located on the Red River downstream from the Red River fish hatchery. These two sites were sampled in 1999, to provide additional information on the aquatic populations in the Red River for use in the TMDL study.

Study site locations for the ten monitoring sites and the two additional sites added for the TMDL study in 1999 (Fig. 1) are as follows:

Middle Fork, Red River	Located approximately 6 mi upstream of the town of Red River and approximately 0.6 mi upstream of the confluence with the East Fork, at an elevation of approximately 9,510 ft. This site was added in 1999 in conjunction with the TMDL study.
Red River	
Upstream of town of Red River	Located approximately 0.6 mi upstream from Goose Creek, 0.2 mi upstream from the gaging station at an elevation of approximately 8,900 ft.
June Bug Campground	Located near the upstream end of June Bug Campground at an elevation of approximately 8,530 ft.
Downstream of Elephant Rock Campground, upstream from Hansen Creek	Located 0.4 mi downstream from Elephant Rock Campground at an elevation of approximately 8,360 ft.
Downstream of Hansen Creek, upstream of mill	Located 0.8 mi upstream from mill access road, 0.7 mi upstream downstream from Hansen Creek, at an elevation of approximately 8,200 ft This site corresponds to the "Bobita Campground" site of the New Mexico Game and Fish Department.
Downstream of mill, upstream of Columbine Creek	Located 1.1 mi downstream from mill access road at an elevation of approximately 8,100 ft.
Goathill Campground	Located at the upstream end of Goathill Campground at an elevation of approximately 7,670 ft.
Upstream of Questa Ranger Station	Located 0.4 mi upstream from ranger station access road, just upstream from where tailings pipes cross over the Red River. The elevation of this site was approximately 7,480 ft.
Upstream of hatchery diversion	Located 0.3 mi upstream of the Red River fish hatchery diversion, at an elevation of approximately 7,120 ft.

Downstream of hatchery	Located 0.3 mi downstream of the Red River fish hatchery adjacent to the USGS gage, at an elevation of 7,070 ft. The site was added in 1999 in conjunction with the TMDL study
Tributaries	
Columbine Creek	Located approximately 400 yards upstream from its confluence with the Red River, at an elevation of approximately 7,880 ft.
Cabresto Creek	Located 1.6 mi upstream of the Carson National Forest boundary, at an elevation of approximately 7,640 ft.

METHODS

Habitat Measurements

Aquatic habitat was measured at all study sites in September 1999 in conjunction with fish population sampling. Each site was categorized into various habitat types (i.e., "units"), such as low or high gradient riffle, pool, and run, as defined in Overton *et al.* (1997). The following measurements were collected in each habitat unit:

1. Length of habitat unit
2. Wetted width
3. Maximum depth
4. Average depth
5. Length of eroding bank
6. Area of cover suitable for fish provided by:
    a. undercut bank
    b. water deeper than 2 ft
    c. pocket water
    d. root wads and woody debris
    e. overhanging vegetation
    f. cut bank
7. Percentage of canopy shading by riparian vegetation

Cover was identified in each habitat unit based on the professional judgement of the field crew. A location in the stream that was judged to be suitable for use by trout as a holding or resting area was considered to be cover. The surface area of the stream (ft^2) that was suitable cover was measured with a tape measure or, in the case of small areas of cover, visually estimated. Each area of cover was attributed to only one of the different cover types, i.e., the cover types do not overlap.

Canopy shading was estimated for each habitat unit at the study sites. The percent of the stream surface area shaded by riparian vegetation was visually evaluated using professional judgement.

Fish Sampling

Fish populations were quantitatively sampled at twelve sites in September 1999, using methods nearly identical to those used in 1997 and 1998. Sampling provided data on species composition, density, biomass, and the size structure of the fish communities. The section of stream sampled at each site was chosen to be representative of the habitat present in that reach of stream, in terms of pool/riffle ratio, shading, bank stability, etc. Sites were of sufficient length to ensure a representative section of the available habitat features: 248 to 432 ft in length at the ten sites on the Red River, 293 ft in Cabresto Creek, and 284 ft in Columbine Creek.

Sampling was conducted by making two or three sampling passes through a representative section of stream using either bank or backpack electrofishing gear. Bank electrofishing equipment consisted of a 4,000 watt generator, a Coffelt voltage regulator (VVP-15), and two or three electrodes. Backpack electrofishing equipment consisted of a Coffelt BP-4 unit with one electrode. At most sites, sample sections were blocked with seines (⅛ inch mesh) on both the upstream and downstream ends to reduce the potential for fish to enter or leave the study section during sampling. However, in some cases, a natural barrier to fish movement (e.g., riffle or plunge pool) was used as a site boundary.

Fish captured from each pass were kept separate to allow estimates of population density of each species using the maximum likelihood estimator in the "MicroFish" program developed by the U.S. Forest Service (Van Deventer and Platts 1983, 1989). All fish sampled were identified, counted, weighed, and released. This sampling provides species lists, estimates of density (#/Mile, #/Acre), and biomass (Lbs/Acre).

Benthic Invertebrate Sampling

Benthic invertebrates were sampled in September 1999, at the twelve sampling locations. Sampling was conducted concurrently with fish sampling. Sampling methods were similar to those used in 1995 by NMED (Woodward-Clyde 1996) and by CEC in 1997 and 1998 (CEC 1997, 1998, 1999), and are briefly described below.

Benthic invertebrates were quantitatively sampled at the twelve sites by taking five replicate samples from similar riffle habitats. A modified Hess sampler, which encloses 0.1 m^2 and has a net mesh size of 500 μm (Canton and Chadwick 1984), was used to collect the invertebrate samples. Five replicate Hess samples were also collected in 1995 by NMED (Woodward-Clyde 1996). Five replicates should provide a reliable estimate of both density and species composition (Canton and Chadwick 1988).

Collected organisms were preserved in the field with 95% ethanol and returned to Chadwick & Associates, Inc. laboratory for analysis. In the lab, organisms were sorted from the debris, identified to the lowest practical taxonomic level (depending upon the age and condition of each specimen), and counted. Chironomids were mounted and cleared prior to identification and counting.

This analysis provided species lists, estimates of density (#/m^2), and the total number of taxa present at each site. Further analysis included calculation of the Shannon-Weaver Diversity Index (H'), which the EPA recommends as a measure of the effects of stress on invertebrate communities (Klemm *et al.* 1990). This index generally has values ranging from 0 to 4, with values greater than 2.5 indicative of a healthy invertebrate community. Diversity values less than 1.0 indicate a stream community under severe stress (Wilhm 1970, Klemm *et al.* 1990).

In mountain streams, such as those near the Molycorp Molybdenum Mine, the presence of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (collectively referred to as the EPT taxa) can be used as an indicator of water quality. These insect groups are considered to be sensitive to a wide range of pollutants (Wiederholm 1989, Plafkin *et al.* 1989, Klemm *et al.* 1990, Lenat and Penrose 1996, Wallace *et al.* 1996). Stress to aquatic systems can be evaluated by comparing the number of EPT taxa and the percent of EPT taxa (expressed as the percent of the number of EPT taxa relative to the total number of taxa) between unimpacted and potentially impacted sites. Impacted sites would be expected to have fewer EPT taxa and lower percent EPT taxa compared to unimpacted sites. Clements (1991, 1994) and Clements *et al.* (1988) indicate that when specifically looking at impacts due to metals, mayflies are particularly sensitive and caddisflies are less sensitive, and this should be taken into account when interpreting EPT parameters.

To assess potential statistical differences in fish and benthic invertebrate population parameters between study sites and between population parameters and physical/chemical parameters, one-way analysis of variance (ANOVA) with Fisher least significant difference test and/or simple regression analyses were performed (Hintze 1997). In this report, a level of 95% ($p = 0.05$) was used to indicate significance. For the parameters of invertebrate density, number of taxa, number of EPT taxa, percent EPT taxa, and diversity, ANOVA was performed using the means of the five individual sample replicates. However, benthic invertebrates are often found in "clumped" or negative binomial distributions. Therefore, in order to fulfill the assumptions needed to use ANOVA, the invertebrate density data were assessed to determine if they needed to be transformed ($\log_{10}$) prior to analysis (Elliott 1977). The statistical analyses were conducted on the mean and variance of the data for the five replicates. The summary data table in this report presents composite mean density values (untransformed). However, for the other parameters analyzed (total number of taxa, number of EPT taxa, percent EPT taxa, diversity), the summary data table presents the results of pooled numbers from the total of the five replicates.

Sediment Sampling

Sediment was sampled at all study sites in September 1999, concurrently with fish and benthic invertebrate population sampling. Sediment was collected from similar riffle habitat to where the benthic invertebrates were sampled. Sediment samples were obtained using a freeze core technique, similar to methods outlined in Grost *et al.* (1991). A stainless steel probe, with a hollow core and solid conical point at the bottom end, was driven into the substrate to with a hammer, to a depth of approximately eight inches. Once the probe was in place, carbon dioxide was injected into the probe for up to one minute. The carbon dioxide was delivered to the probe by a narrow stainless steel tube placed inside the probe. The delivery tube was attached to a 20 pound cylinder of liquid carbon dioxide. After approximately 40-60 seconds, the frozen probe, along with the frozen sediment clinging to it (i.e., "freeze core") was lifted from the substrate and placed into an enamel pan. The frozen sediment was then melted off the probe using a propane torch and placed into a plastic bag. Three or more freeze cores were taken at each site and combined into one composite sample from each site. Sediment samples were shipped to ACZ Laboratories for analysis.

Sediment was sampled to provide data on the extent of fine sediments as well as metals analysis of the fine particles. In the lab, the sediment samples were separated through a 2 mm sieve. The proportion of the sample passing through the sieve was used as a measure of the extent the substrate had accumulated fine sediment particles. The fines were analyzed for texture (i.e., sand, silt, clay).

The fine sediment particles passing through the sieve were also analyzed for metals concentrations by a weak acid leach process. The resulting leachate was analyzed for total concentrations of cadmium, chromium, copper, lead, and zinc. The results were reported as the concentrations of these metals (mg/Kg) in the fine sediments.

RESULTS AND DISCUSSION

Habitat

Mean width of the study sites ranged from 9.2 ft in the Middle Fork of the Red River, to 24.4 ft at the lowest site on the Red River, downstream of the fish hatchery (Table 1). These differences reflect the longitudinal influences of location within the drainage, with sites closer to the headwaters having narrower channels and less flow than sites farther downstream. Most of the mean widths ranged from 15 to 20 ft. Mean depth also reflected the longitudinal influence, with downstream sites having greater mean depths (Table 1). Maximum depths did not exhibit a clear pattern, although the two most downstream sites on the Red River had the greatest maximum depths.

The highest levels of canopy shading (i.e., stream shading) were observed at the smallest stream sites: in the Middle Fork of the Red River and the two tributaries, Columbine and Cabresto creeks (Table 1). The amount of eroding bank varied from 0% at four sites to 53% at the site upstream from Columbine Creek. The highest levels of eroding bank in the Red River occurred from the June Bug Campground site downstream to the Questa Ranger Station.

TABLE 1: Summary of general habitat features of study sites in the Red River drainage, September 1999. Amount of eroding bank is for left and right bank combined, as a percentage of total bank length.

Site	Site Length (ft)	Mean Width (ft)	Water Depth (ft)		Canopy Shading (%)	Eroding Bank (%)
			Mean	Max		
Middle Fork, Red River	248	9.2	0.6	1.2	64	4
Red River						
Upstream of Town of Red River	421	18.4	0.7	2.2	22	0
June Bug Campground	339	17.5	0.8	2.5	12	37
Downstream of Elephant Rock Campground, upstream of Hansen Creek	292	19.3	0.9	2.6	9	12
Downstream of Hansen Creek, upstream of mill	328	17.2	1.0	1.6	44	9
Downstream of mill, upstream of Columbine Creek	288	16.8	1.1	1.8	17	53
Goathill Campground	432	19.6	1.1	2.2	23	38
Upstream of Questa Ranger Station	427	19.5	1.0	2.3	19	42
Upstream of hatchery diversion	346	20.0	1.7	3.5	6	0
Downstream of hatchery	383	24.4	1.5	3.6	27	0
Tributaries						
Columbine Creek	284	12.2	0.6	1.5	65	0
Cabresto Creek	293	10.8	0.7	2.1	68	20

Riffles (low- and high-gradient) and runs dominated the habitat types at all the study sites (Table 2). Runs were the predominant type at three of the study sites, and riffles at the others. Pools were either absent or comprised a small proportion of the habitat. This predominance of riffles and runs is not unusual for a Rocky Mountain stream.

TABLE 2: *Habitat type composition of study sites in the Red River drainage, September 1999.* Values are percent of total area with number of discrete habitat units in parentheses. LGR = low gradient riffle, HGR = high gradient riffle, MCP = mid-channel pool, LSP = lateral scour pool, RUN = run.

	% Area (No. of Units)				
Site	LGR	HGR	MCP	LSP	RUN
Middle Fork, Red River	36 (3)	13 (1)	12 (2)	0	39 (5)
Red River					
Upstream of Town of Red River	58 (4)	0	0	0	42 (6)
June Bug Campground	19 (1)	62 (2)	5 (1)	0	14 (2)
Downstream of Elephant Rock Campground, upstream of Hansen Creek	35 (2)	18 (1)	0	0	47 (3)
Downstream of Hansen Creek, upstream of mill	74 (2)	0	0	0	26 (2)
Downstream of mill, upstream of Columbine Creek	0	66 (3)	0	0	34 (2)
Goathill Campground	19 (2)	60 (4)	5 (2)	0	16 (2)
Upstream of Questa Ranger Station	55 (3)	3 (1)	3 (1)	7 (1)	32 (2)
Upstream of hatchery diversion	0	78 (3)	12 (2)	0	10 (1)
Downstream of hatchery	31 (2)	19 (2)	0	9 (1)	41 (2)
Tributaries					
Columbine Creek	80 (3)	0	6 (1)	0	14 (2)
Cabresto Creek	82 (3)	0	3 (1)	5 (1)	10 (2)

Each of the study sites exhibited combinations of various types of cover, which included habitat features such as undercut or steep banks, deep pools or pockets of slack water areas near boulders, woody debris, and overhanging vegetation (Table 3 and Appendix A). Pocket water (i.e., deeper, slow water near boulders) was the dominant cover type in five study sites, as was undercut bank at three sites, and woody debris at three sites. The overall amount of cover at each study site (expressed as a percentage of the total site area) ranged from 0.9% at the site downstream from Hansen Creek to 8.1% at the site downstream from the fish hatchery, with no clear longitudinal pattern.

TABLE 3: Summary of cover-related habitat features of study sites in the Red River drainage, September 1999. Values for these parameters represent percentage of the total site area.

Site	Undercut Bank	Deep Water	Pocket Water	Wood	Overhang. Veg.	Total Cover
Middle Fork, Red River	0.4	0	2.3	1.5	0.4	4.6
Red River						
Upstream of Town of Red River	0.4	0.1	0.6	0.7	0	1.8
June Bug Campground	2.9	0.3	2.7	0.1	0	6.0
Downstream of Elephant Rock Campground, upstream of Hansen Creek	2.5	0.2	0.8	0.2	0.3	4.0
Downstream of Hansen Creek, upstream of mill	0	0	0.9	0	0	0.9
Downstream of mill, upstream of Columbine Creek	0	0	2.1	0.4	0.1	2.6
Goathill Campground	0.3	0	3.4	0.2	0.3	4.2
Upstream of Questa Ranger Station	0.6	0.4	1.3	0.1	0.2	2.6
Upstream of hatchery diversion	0	4.7	2.5	0.4	0	7.6
Downstream of hatchery	0	2.6	1.7	3.8	0	8.1
Tributaries						
Columbine Creek	1.5	0	0.8	0	0.6	2.9
Cabresto Creek	0.8	0.1	0.9	1.0	0	2.8

Fish

Four different trout species were collected in the Red River and its tributaries during sampling in September 1999 (Table 4). Overall, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) were the most common species collected. Brown trout were collected at nine of the ten sites in the Red River and in Columbine Creek and Cabresto Creek. Rainbow trout were collected at all ten sites in the Red River and in Cabresto Creek. Brook trout (*Salvelinus fontinalis*) were the most abundant species at the site in the Middle Fork, and the site in the Red River upstream of the town of Red River; they were present at one other site in the Red River and in Cabresto Creek. Cutthroat trout (*Salmo clarki*) were present at one site in the Red River and in Columbine Creek. Hybrid rainbow/cutthroat trout were present at the site in the Red River upstream of the town of Red River, and were the most common fish in Cabresto Creek, as was also true in spring and fall 1997 and fall 1998 (CEC 1997, 1998, 1999).

TABLE 4: Fish population parameters for study sites on the Red River and tributaries. Data collected in September 1999 by Chadwick Ecological Consultants, Inc. Data from all electrofishing passes. (CUT = cutthroat trout, BRK = brook trout, RBT = rainbow trout, BRN = brown trout, HYBRID = cutthroat/rainbow hybrid, WHS = white sucker).

			Density		Biomass
Site	Species	# Collected	#/Mile	#/Acre	Lbs/Acre
Middle Fork, Red River	BRK	25	532	472	56.8
	RBT	7	149	132	44.3
	Total	**32**	**681**	**604**	**101.1**
Red River					
Upstream of Town of Red River	BRK	23	326	139	16.4
	RBT	13	163	70	49.8
	BRN	6	75	32	9.1
	HYBRID	4	50	21	1.2
	Total	**46**	**614**	**262**	**76.5**
June Bug Campground	RBT	5	78	36	16.2
	BRN	16	296	137	23.7
	Total	**21**	**374**	**173**	**39.9**
Downstream of Elephant Rock Campground, upstream of Hansen Creek	BRK	2	36	16	0.1
	RBT	3	54	23	10.5
	BRN	39	796	344	85.2
	Total	**44**	**886**	**383**	**95.8**
Downstream of Hansen Creek, upstream of mill	RBT	1	16	7	3.7
	BRN	14	225	103	25.5
	Total	**15**	**241**	**110**	**29.2**
Downstream of mill, upstream of Columbine Creek	CUT	2	37	18	3.8
	RBT	2	37	18	15.2
	BRN	17	312	155	45.2
	Total	**21**	**386**	**191**	**64.2**
Goathill Campground	RBT	2	24	10	5.9
	BRN	30	378	153	27.0
	WHS	3	37	15	1.2
	Total	**35**	**439**	**178**	**34.1**

TABLE 4: Continued.

Site	Species	# Collected	Density #/Mile	Density #/Acre	Biomass Lbs/Acre
Upstream of Questa Ranger Station	RBT	1	12	5	2.6
	BRN	13	173	71	10.8
	WHS	3	37	15	0.6
	Total	**17**	**222**	**91**	**14.0**
Upstream of hatchery diversion	RBT	23	351	146	42.5
	BRN	27	443	185	26.3
	Total	**50**	**794**	**331**	**68.8**
Downstream of hatchery	RBT	10	138	47	12.2
	BRN	60	883	302	107.2
	Total	**70**	**1,021**	**349**	**119.4**
Tributaries					
Columbine Creek	CUT	1	19	13	2.4
	BRN	35	706	500	55.8
	Total	**36**	**725**	**513**	**58.2**
Cabresto Creek	BRK	9	162	106	4.2
	RBT	11	198	129	49.9
	BRN	2	36	24	2.8
	HYBRID	70	1,586	1,035	81.7
	Total	**92**	**1,982**	**1,294**	**138.6**

Multiple size-classes of cutthroat, brook, brown, and hybrid trout were collected. This indicates the presence of resident, self-sustaining populations of these species in the Red River and its tributaries. The rainbow trout collected were 6 inches in length or greater (with the exception of one 4.8-inch fish at the site downstream from the hatchery, which probably escaped from the hatchery), with most in the 8- to 11-inch size group (Appendix B). This corresponds to the lengths of fish regularly stocked by NMDGF and the town of Red River (CEC 1997). As was true in 1997 and 1998, the rainbow trout collected during sampling in fall 1999 are probably stocked fish. In order to minimize the effect of stocked fish on the interpretation of the data, the following discussions are based on trends in resident trout (defined as all trout, excluding rainbow trout).

The fish population data from fall 1999 indicate a distinct pattern of trout density in the Red River from above the town of Red River, downstream to the Red River Fish Hatchery (Fig. 2). Estimates of total number of trout and resident trout generally have been higher at sites upstream of Hansen Creek. Density of resident trout at the four sites upstream of Hansen Creek ranged from 296 to 832 trout per mile (Table 4, Fig. 2), averaging 528 trout per mile in 1999.

At the June Bug Campground site, the density of resident trout was lower than at the other three sites in the two reaches of the Red River upstream of Hansen Creek (Table 4, Fig. 2). There was a decrease of 44% and 32% in the density of resident trout between the two sites upstream of the town of Red River and the site at the June Bug Campground. This pattern was also observed in previous years, suggesting an impact to trout populations is occurring adjacent to or near the town of Red River.

A relatively high density of resident trout was present at the Elephant Rock Campground site, higher than levels found at the two sites upstream of the town of Red River (Fig. 2). At the next site downstream, below Hansen Creek, there was a decrease in resident trout density of 73%. Resident and total trout density remained relatively low at the next four sampling sites from Hansen Creek downstream, reaching a minimum of 173 resident trout per mile at the site near the Questa Ranger Station, downstream of Capulin Canyon (Table 4). At the next site downstream, near the fish hatchery, resident trout density increased approximately 156% to a level that is within the range of sites upstream of Hansen Creek. Resident trout density in the Red River was the highest at the site downstream from the fish hatchery.

Trout biomass can be another useful indication of the status of the aquatic environment. While density can be skewed by high numbers of small, young-of-the-year (YOY) fish or low numbers of older fish, biomass accounts for fish size (weight) and can be a more stable and useful indicator from year to year. In past reports, trout biomass was not the focus of our evaluation because much of the historic sources reported only density data. However, the results of fish sampling by CEC in 1997, 1998, and 1999 (as well as the more recent results from NMDGF) include biomass data, allowing year-to-year comparisons to be made using this measurement. The trend in trout biomass in 1999 was very similar to that of trout density, exhibiting higher levels upstream of Hansen Creek and downstream of Questa (Fig. 3).

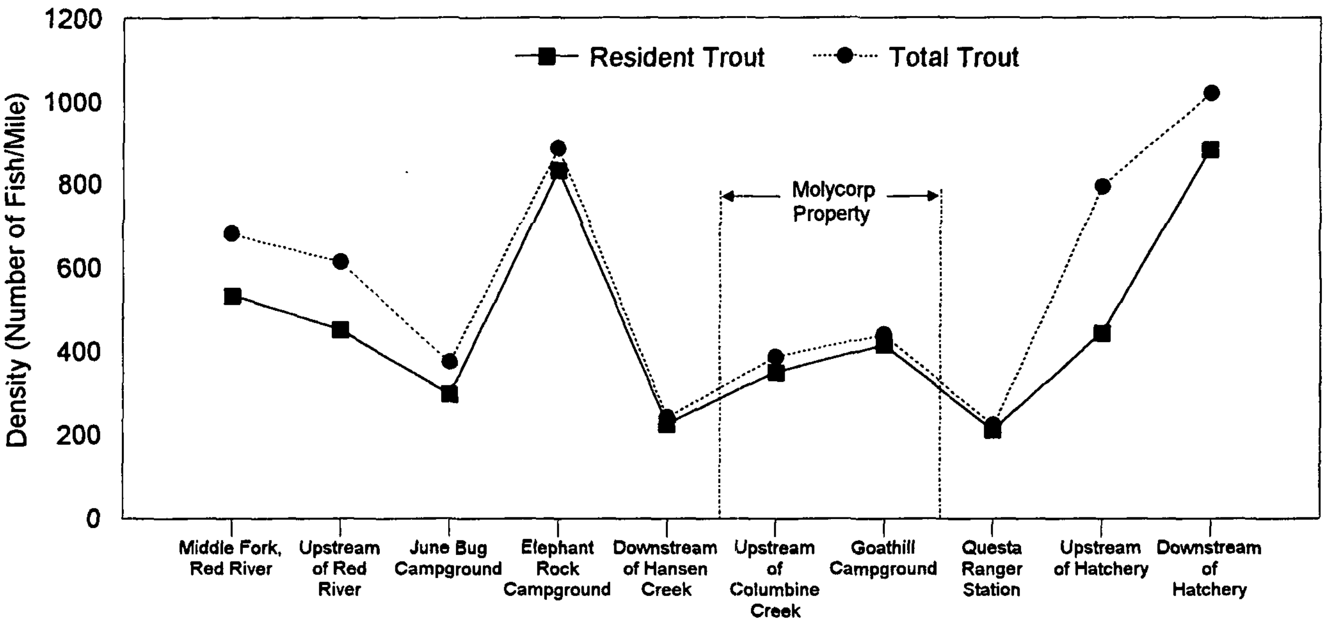

FIGURE 2: Trend in trout density (number per mile) for data collected in fall 1999. Data represent results from all electrofishing passes. Resident trout excludes rainbow trout.

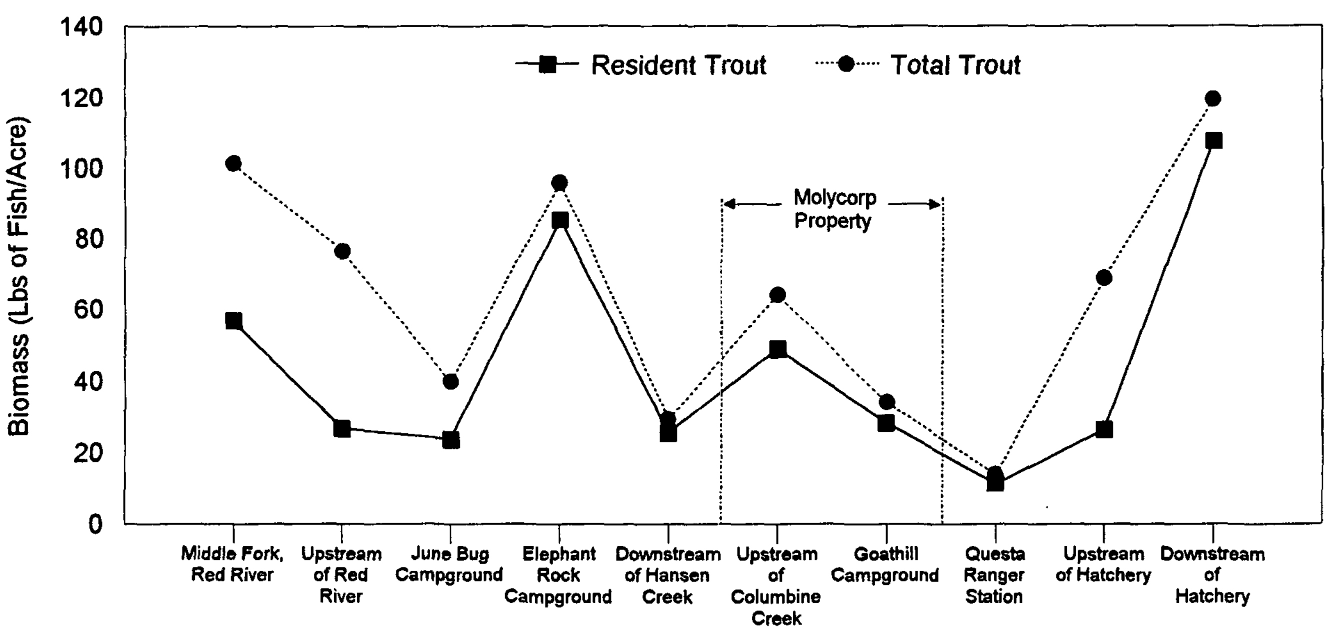

FIGURE 3: Trend in trout biomass (pounds per acre) for data collected in fall 1999. Data represent results from all electrofishing passes. Resident trout excludes rainbow trout.

The patterns in both trout density and trout biomass suggest that there may be at least three sections of the Red River showing negative impacts to aquatic biota. The data from 1999 clearly indicate that Hansen Creek continues to result in a substantial impact to the aquatic biota of the Red River. Our earlier reports also suggested that there were impacts near the town of Red River and/or from Bitter Creek or Hot-n-Tot Creek that resulted in the reductions in trout populations evident at the June Bug Campground site. The data for 1999 support this. However, there also appears to be another impact area downstream of Goathill Campground. In 1999, trout density and biomass levels at the site upstream of Columbine Creek and at Goathill Campground indicated some recovery was occurring from the impacts of Hansen Creek (Figs. 2, 3). Dilution effects from Columbine Creek and YOY brown trout spawned in Columbine Creek may contribute to this recovery. However, at the next site downstream, near the Questa Ranger Station, trout population levels decrease substantially, suggesting further impacts downstream of Goathill Campground. Capulin Canyon and Capulin Springs discharge into the Red River just upstream of the site near the Questa Ranger Station, and may be responsible for the reduction in trout populations.

Cabresto and Columbine Creeks represent unimpacted streams in the area. Although they are both smaller in size than the Red River, they give some suggestion of the range of trout density and biomass that may be expected in the Red River if no impacts were present. Resident trout density in Cabresto Creek in 1999 was approximately twice as high as the highest density recorded in the Red River, downstream of the fish hatchery (Table 4). Biomass of resident trout in Cabresto Creek was less than that found at the site downstream of the fish hatchery and similar to that found at the Elephant Rock Campground site. This pattern of density and biomass reflects the fact that resident fish are larger in the Red River. The data from Columbine Creek represent density and biomass values for resident trout approximately in the upper portion of the range present in the Red River in 1999. These comparisons suggest that some sections of the Red River (upstream of Red River, near the Elephant Rock Campground, near the fish hatchery) are exhibiting only slight impacts as compared to other streams in the region.

Multiple regression analysis was conducted to determine if any of the habitat parameters were related to resident trout density and biomass. Since cover can be an important parameter related to abundance of trout (Binns and Eiserman 1979), it was thought that if cover was the limiting factor in the Red River, the total percentage of all cover types at each study site on the Red River would be related to trout abundance.

However, there was no relationship to either trout density ($p = 0.80$, $R^2 = 0.01$) or trout biomass ($p = 0.35$, $R^2 = 0.09$), indicating that the total percentage of cover at a site did not explain the trends in trout abundance.

A significant positive, but somewhat weak, relationship was found between the percentage of pool and run habitat (combined) at each site and trout biomass ($p = 0.05$, $R^2 = 0.41$) (Fig. 4). For trout density, the relationship was very close to being significant at the 95% level ($p = 0.07$, $R^2 = 0.36$) (Fig. 5). These results indicate that the percentage of pool and run habitat at a site seemed to explain 36% of the variation in trout density and 41% of the variation in trout biomass. As the amount of pool and run habitat increased, so did trout abundance. This relationship makes sense from an ecological perspective, since pools and runs offer resting and hiding places for trout that are not present in riffles.

The regressions between the percentage of pool and run habitat and trout population parameters showed that the site at the Questa Ranger Station fell well below the regression line for both density and biomass (Figs. 4, 5). Similarly, the site downstream from the hatchery fell well above the regression line. These data suggest that there are some other parameters (e.g., water quality) determining trout density and biomass in the Red River. For example, Capulin Canyon may be negatively impacting water quality near the Ranger Station, and outflow from the fish hatchery may be enriching the stream productivity downstream from the hatchery. In contrast, the points for the sites below Hansen Creek, above Columbine Creek, and at Goathill Campground fall much closer to the regression lines, indicating that the percentage of pool and run habitat is more closely related to trout abundance at these sites.

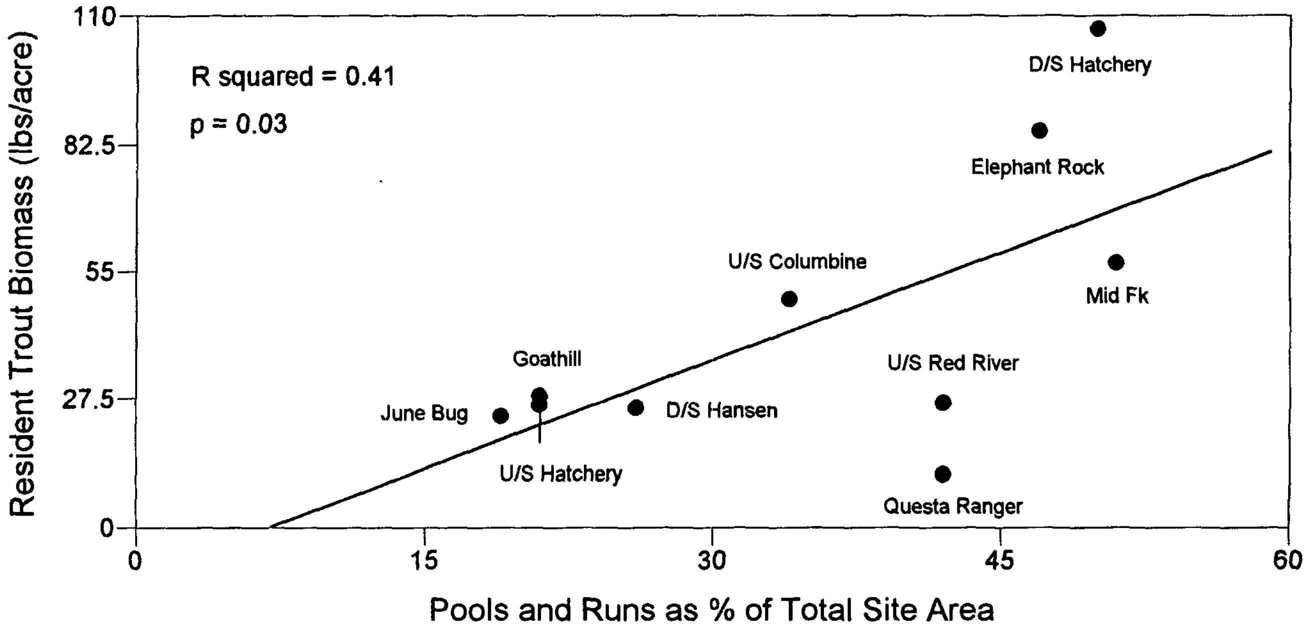

FIGURE 4: Relationship between resident trout biomass and total percentage of pool and run area, Red River, 1999.

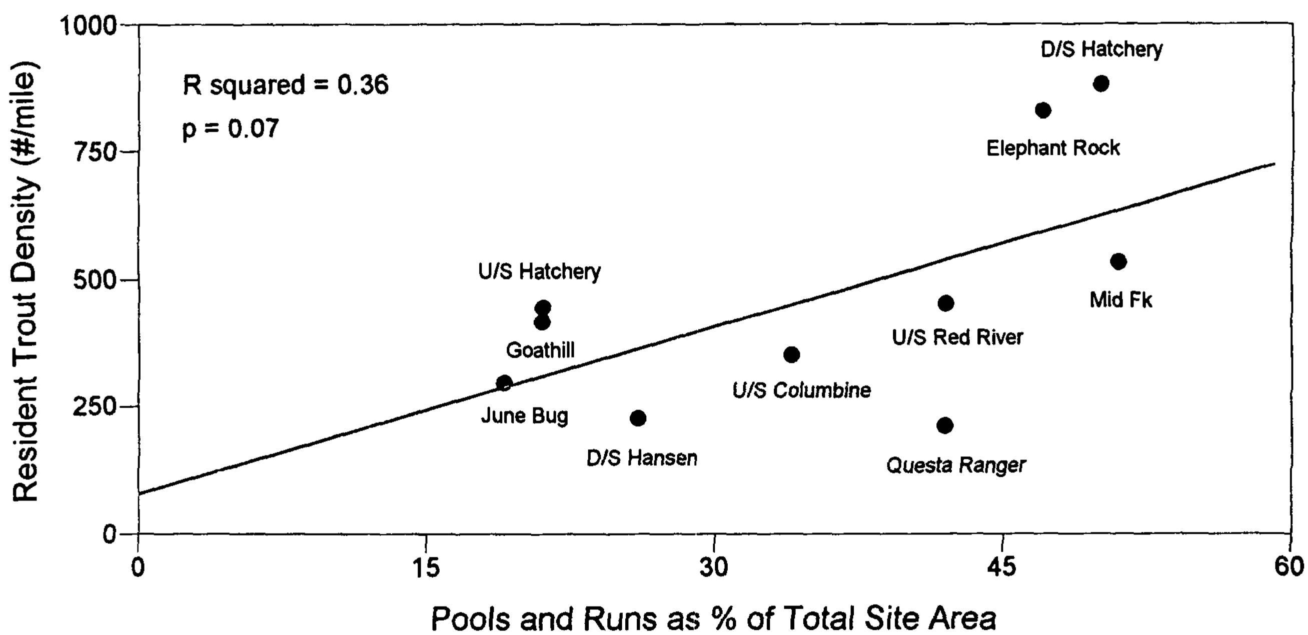

FIGURE 5: Relationship between resident trout density and total percentage of pool and run area, Red River, 1999.

Benthic Invertebrates

Columbine and Cabresto creeks represent relatively unimpacted streams in the Red River Valley. Therefore, benthic invertebrate population parameters for these two sites can be used as comparisons to evaluate the relative levels of impact in the Red River. The site on the Red River upstream of the town of Red River also, in the past, has been used to represent conditions that are relatively unimpacted, at least with respect to the Molycorp mine. Likewise, benthic invertebrate data from the Middle Fork site sampled in 1999 can be used to represent unimpacted conditions. In 1998, data indicated that at the site upstream of the town of Red River, most benthic invertebrate population parameters were lower than would be expected compared to the two tributaries (CEC 1999). However, in 1999, population parameters were more comparable between the site upstream of the town of Red River, the Middle Fork, and the two tributaries. Although some significant differences between these four sites were observed for density, number of taxa, and number of EPT taxa ($p < 0.05$), there was no clear pattern, which suggests natural variation. Diversities were high and not significantly different ($p > 0.05$) for all four of these sites, well above the threshold value of 2.5 that generally indicates stress to benthic invertebrate communities (Wilhm 1970, Klemm *et al.* 1990, CEC 1997). These results indicate that the two upstream sites on the Red River are comparable to the two unimpacted tributaries, and these four sites combined should provide suitable in-stream comparison data for the other Red River sites.

For three parameters (total number of taxa, number of EPT taxa, and diversity), the values at the four reference sites (combined) were significantly higher ($p < 0.05$) than at all the sites on the Red River from the town of Red River downstream to past the hatchery. This clearly indicates that there are significant impacts to benthic invertebrate populations along the length of the river downstream of the town of Red River. All three of these parameters are also commonly used to evaluate impacts due to water quality. These significant differences imply that there are water quality impacts to the Red River along much of its length.

Benthic invertebrate density at most sites in the Red River was not significantly different from the four reference sites, with the exception of the three sites in the middle reaches of the Red River (downstream of mill, Goathill Campground, and the Questa Ranger Station). For the parameter of percent EPT taxa, most sites along the river were significantly lower than at the reference sites, with the exception of the site downstream of the fish hatchery and, unexpectedly, the site upstream of the Questa Ranger Station. This confusing pattern of differences suggest there may be multiple physical and chemical impacts to benthic invertebrates along the length of the Red River.

For the section of river downstream of the town of Red River, density was relatively high at the June Bug and Elephant Rock Campground sites (Table 5, Fig. 6). However, number of taxa, number of EPT taxa, and percent of EPT taxa at these sites were low compared to most other sites. Diversity was greater than 3.0 at the Elephant Rock site, indicating a balanced population. As was the case in 1998, this "mixed bag" of high and low population parameters suggests that impacts (possibly enrichment and sedimentation) are occurring in the reach between the town of Red River and Hansen Creek, but the impacts are not severe and some sensitive forms of aquatic invertebrates are able to be sustained in this reach.

TABLE 5: Benthic invertebrate population parameters for collection sites on the Red River and tributaries. Data collected in September 1999 by Chadwick Ecological Consultants, Inc.

Site	Density (#/m^2)	Total # of Taxa	# EPT Taxa	EPT Taxa as % Total Taxa	Diversity Index (H')
Middle Fork, Red River	4,900	33	19	58	3.92
Red River					
Upstream of Town of Red River	7,424	36	17	47	3.78
June Bug Campground	4,180	28	10	36	2.68
Downstream Elephant Rock Campground, upstream of Hansen Creek	6,630	26	10	38	3.15
Downstream of Hansen Creek, upstream of mill	3,824	35	16	46	2.65
Downstream of mill, upstream of Columbine Creek	2,740	30	13	43	3.36
Goathill Campground	2,732	27	12	44	2.78
Upstream of Questa Ranger Station	1,240	22	13	59	2.42
Upstream of hatchery diversion	5,536	29	14	48	2.60
Downstream of hatchery diversion	2,908	28	13	46	2.49
Tributaries					
Columbine Creek	2,036	35	21	60	3.99
Cabresto Creek	9,584	41	24	59	4.06

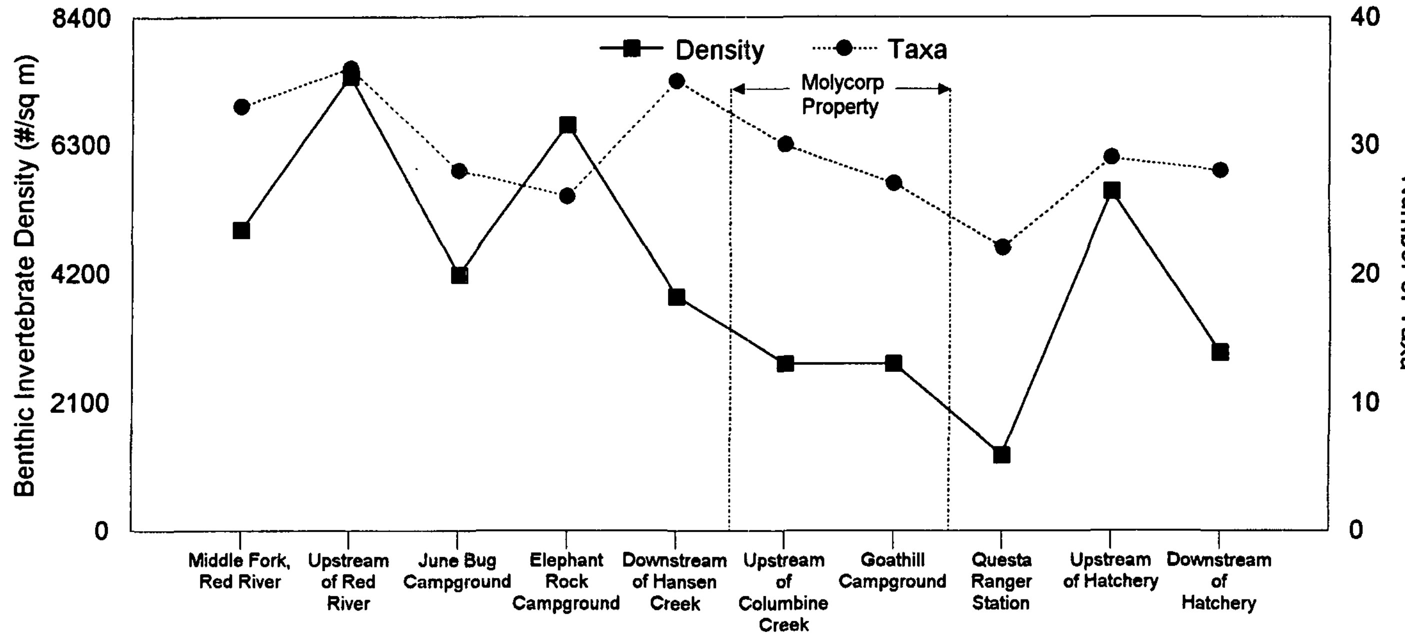

FIGURE 6: Trend in benthic invertebrate density and number of taxa for data collected in fall 1999.

Downstream of Hansen Creek, benthic invertebrate density was reduced by 42% as compared to the next site upstream, Elephant Rock Campground. However, this difference was not significant ($p > 0.05$). Totals for number of taxa, number of EPT taxa, and percent of EPT taxa were greater than at Elephant Rock Campground, but these differences were not significant ($p > 0.05$) when comparing means from replicates. However, the reduced diversity (2.65) downstream of Hansen Creek compared to upstream sites and tributaries suggests some water quality impacts may be present.

At the two sites in the reaches adjacent to the Molycorp property (downstream of the mill/upstream of Columbine Creek and Goathill Campground), most population parameters were similar. The patterns for density and number of taxa suggest lower values for the two sites compared to just below Hansen Creek (Fig. 6). However, for density, these differences were not significant ($p > 0.05$). In addition, mean number of taxa from replicates at the site upstream of Columbine Creek was not significantly different from just below Hansen Creek ($p > 0.05$). Although number of taxa at Goathill Campground was significantly reduced compared to just below Hansen Creek, values for number and percentage of EPT taxa were similar between sites, indicating similar population parameters between the site just below Hansen Creek and the next two sites downstream, located within Molycorp boundaries. At all three of these sites, the species composition included numerous mayfly species, which are considered to be particularly sensitive to metals impacts (Clements 1991, 1994; Clements *et al.* 1988) as well as the more tolerant caddisflies (Appendix C). The reduced densities at these two sites compared to sites above Hansen Creek suggest impacts from Hansen Creek are still present, while the moderate to high percent of EPT taxa and the presence of multiple mayfly species indicate that this reach of the river is able to sustain sensitive aquatic insect species. The diversity at the site downstream of the mill, and upstream of Columbine Creek (3.36), was higher than at any other site on the Red River downstream from the town of Red River in 1999.

The site near the Questa Ranger Station had significantly ($p < 0.001$) lower density, total number of taxa, and diversity of all the sites sampled in 1999 (Table 5), indicating significant impairment to the aquatic community. However, number of EPT taxa was within the range of other sites on the Red River, the percent EPT taxa was among the highest at any site, was not significantly different from the reference sites, and four species of mayflies were present (Appendix C). This indicates a continuing impact downstream of Capulin Canyon and Capulin Springs leading to a reduced density, total number of taxa, and diversity, but that some sensitive forms of invertebrates are still present.

The final two sites on the Red River, upstream and downstream of the fish hatchery diversion, demonstrated a recovery in density and total number of taxa (Fig. 6). The densities of benthic invertebrates were significantly ($p < 0.001$) higher compared to the Questa Ranger Station site. This recovery is probably due, in part, to the input of dilution water from Cabresto Creek.

The overall longitudinal trend along the Red River shows a gradual declining pattern in the total number of taxa, with the lowest number of taxa at the site near the Questa Ranger Station (Fig. 6). However, even at this site, the number of taxa present (22) was more than half that of the reference sites upstream of Red River and in the tributaries. This trend suggests that conditions along the length of the Red River are suitable to sustain at least some sensitive benthic invertebrate taxa. Although impacts are apparent, these impacts do not render the river unsuitable to benthic invertebrates.

The trend in benthic invertebrate density in the Red River was more variable than that for number of taxa (Fig. 6). Four of the ten sites sampled in the Red River contained densities of invertebrates greater than 4,900/m^2, including the site upstream of the hatchery diversion. Much lower densities were found at the four sites from Hansen Creek downstream to the Questa Ranger Station (Fig. 6).

The benthic invertebrate data from 1999 indicate two general areas of impact on the Red River. However, the trends in benthic invertebrate population parameters, especially number of taxa, are not as clear as they were for fish population parameters. The most substantial section of impact to benthic invertebrate populations occurs downstream of Hansen Creek and extends to the Questa Ranger Station. The reduction in density (Fig. 6) and the relatively low diversity (Table 5) suggest both habitat impacts and water quality impacts. The fact that the number of taxa remains relatively high at the site downstream of Hansen Creek suggests that the sediment input from Hansen Creek is the more severe impact. Other investigators have also found that sediment inputs can decrease overall density, while community structure (e.g., number of taxa) stays relatively unchanged (Lenat *et al.* 1981). The most severe impact in this section appears downstream of Capulin Canyon and Capulin Springs, at the Questa Ranger Station.

Impacts near the town of Red River have been seen in the past (CEC 1997, 1998, 1999). In 1999, these impacts apparently resulted in relatively minor changes to benthic invertebrates. Although diversity was relatively low at the June Bug Campground site, density at this site was in the upper half of the range observed in 1999 (Table 5, Fig. 6) and not significantly different from the reference sites.

Sediment

The percentage of fine sediment in riffles varied little from site to site along the length of the Red River (Table 6). The percentage of fines in the Red River ranged from 22.8% at the June Bug Campground site to 34.4% at the site downstream of Hansen Creek. This is similar to the range of 25.4% to 33.9% found in the four reference sites (Columbine and Cabresto creeks, the Middle Fork of the Red River, and the site upstream of Red River). There is no clear longitudinal trend in the percent of fine sediment in riffles along the length of the Red River. There was no relationship between percent fine sediment and benthic invertebrate density ($p = 0.25$)

TABLE 6: Percentage of fines and texture analysis of sediment samples from the Red River and tributaries, September 1999.

Site	% Fines (<2 mm)	Texture % Clay	% Silt	% Silt
Middle Fork, Red River	33.9	5	5	90
Red River				
Upstream of Town of Red River	29.7	5	5	90
June Bug Campground	22.8	10	0	90
Downstream of Elephant Rock Campground, upstream of Hansen Creek	30.9	7	0	93
Downstream of Hansen Creek, upstream of mill	34.4	7	2	90
Downstream of mill, upstream of Columbine Creek	30.4	5	0	95
Goathill Campground	27.4	2	0	98
Upstream of Questa Ranger Station	31.0	7	0	93
Upstream of hatchery diversion	26.6	5	2	93
Downstream of hatchery	26.6	7	0	93
Tributaries				
Columbine Creek	25.4	7	0	93
Cabresto Creek	32.8	7	0	93

The lack of a longitudinal trend in fine sediment, despite the presence of point sources of sediment in the drainage, is probably due to two factors. The first, and probably most important, factor is that the sediment samples were taken from riffle areas similar to the benthic invertebrate sampling locations. These areas of the stream are erosional; the fines apparently are not accumulating in riffles. Although there is sediment accumulation in other habitat types (runs and pools), especially at sites from the town of Red River downstream to the Questa Ranger Stated (based on visual observation), the lack of a longitudinal trend indicates that the sediment load does not exceed the ability of the river to keep excessive levels of sediment from accumulating in the riffles.

The second factor is related to the actual sampling technique used. The freeze core method has been shown to be very effective in quantifying the amount of fine material in the substrate (Petts *et al.* 1989). The technique involves the driving of the core sampler into the substrate. While pounding the sampler with a sledge hammer, the recently deposited fine sediment on the surface of the substrate may be dislodged and lost downstream. Although this technique was the same at every sampling site, it would probably have a greater effect in sampling locations with higher current velocities and/or more densely packed substrate (which requires more pounding to drive in the sampler). However, based on our visual observations, this factor was minor and the riffles at the various sites appeared to be similar in the amount of fines present in 1999.

The texture of the fine sediment also varied very little among sites. Sand accounted for 90-98% of the fine material at all sites (Table 6). Clay particles were present at all sites in small amounts. Silt particles were present in small amounts at only four of the twelve sites.

Results of the sediment metal analysis indicated that concentration of metals was variable between sites, with only one clear longitudinal trend (Table 7, Fig. 7). Zinc exhibited the clearest longitudinal pattern for sediment concentrations, with values increasing in a downstream direction (Table 7, Fig. 7). Sediment from the study site downstream of the fish hatchery had the highest concentration (174 mg/Kg), followed by the sites near the Questa Ranger Station and Goathill Campground (143 and 138 mg/Kg, respectively).

Cadmium concentrations were low, < 0.4 mg/Kg at all sites. Aluminum concentrations did not have a clear longitudinal pattern, with some of the highest concentrations in the tributaries and the upper two sites on the Red River. The highest concentration of aluminum downstream from the town of Red River was measured at the study site downstream of Capulin Springs and upstream of the Questa Ranger Station, with a value of 3,460 mg/Kg (Table 7, Fig. 7). The lowest value (1,820 mg/Kg) was observed at the site just downstream of Hansen Creek.

It is interesting to note that copper, lead, and zinc sediment concentrations increased substantially at the site just downstream of the town of Red River, compared to all four reference sites. In fact, sediment concentrations for copper and lead were only higher at the next site downstream, then generally decreased in a downstream direction.

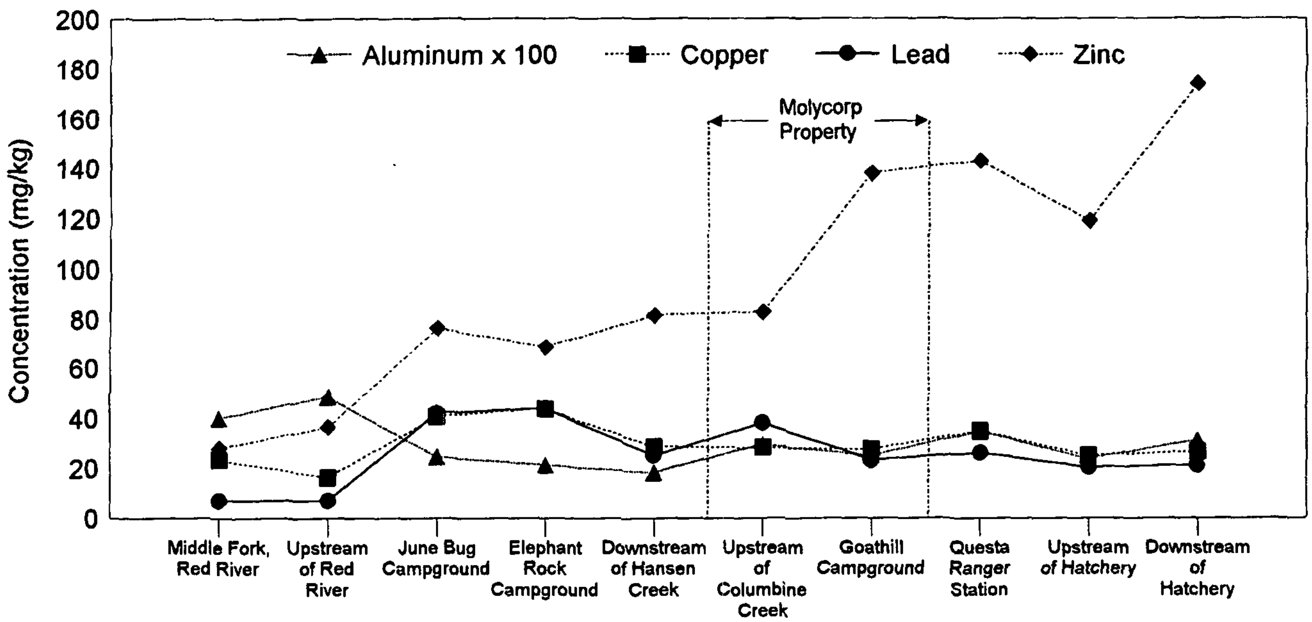

FIGURE 7: Sediment concentrations of aluminum, copper, lead, and zinc from study sites in the Red River drainage, September 1999.

In regard to sediment criteria for heavy metals, very few have been published to date, although Ontario, Canada has sediment criteria that include cadmium, copper, lead, and zinc (Persaud *et al.* 1993). Their sediment quality guidelines have three levels of effect - No Effect Level, Lowest Effect Level, and Severe Effect Level. The No Effect Level describes concentrations that do not affect fish or benthic invertebrates. Sediment at this level is considered clean. The Lowest Effect Level describes concentrations that have no effect on the majority of the fish and benthic invertebrates. Sediment at this level is considered clean to marginally polluted. The Severe Effect Level describes concentrations that are likely to effect the health of fish and benthic invertebrates. Sediment at this level is considered heavily polluted. The latter two levels are based on the long-term effects which the contaminants may have on the sediment-dwelling organisms (benthic invertebrates).

TABLE 7: Concentration of metals (mg/Kg) in sediment samples from study sites on the Red River and tributaries, September 1999.

	Sediment Concentration (mg/Kg)				
Site	Aluminum	Cadmium	Copper	Lead	Zinc
Middle Fork, Red River	4,010	<0.2	23	7	28
Red River					
Upstream of Town of Red River	4,870	<0.4	16	7	36
June Bug Campground	2,450	<0.2	41	42	76
Downstream Elephant Rock Campground, upstream of Hansen Creek	2,130	<0.2	44	44	69
Downstream of Hansen Creek, upstream of mill	1,820	<0.2	29	25	82
Downstream of mill, upstream of Columbine Creek	2,940	<0.4	28	38	83
Goathill Campground	2,490	0.3	28	23	138
Upstream of Questa Ranger Station	3,460	<0.2	35	26	143
Upstream of hatchery diversion	2,360	<0.2	25	20	119
Downstream of hatchery	3,090	<0.2	26	21	174
Tributaries					
Columbine Creek	5,360	<0.4	17	28	64
Cabresto Creek	4,130	<0.4	9	11	76

The metal concentrations in the sediment samples from the Red River drainage were compared to the Ontario standards. Cadmium concentrations were all less than the Lowest Effect Level of 0.6 mg/Kg. Copper concentrations in the Red River drainage ranged from 9 to 44 mg/Kg, with most sites, including tributaries and upstream references sites, being above the Lowest Effect Level of 16 mg/Kg, but much less than the Severe Effect Level of 110 mg/Kg. Concentrations of lead ranged from 7 to 44 mg/Kg in the drainage, with only three sites (Junebug, Elephant Rock, and upstream of Columbine Creek) having levels higher than the Lowest Effect Level of 31 mg/Kg. These three sites had levels of lead just barely above the Lowest Effect Level, and much less than the Severe Effect Level of 250 mg/Kg. Zinc concentrations ranged from 28 to 174 mg/Kg, with three sites (Goathill, Questa Ranger Station, and downstream of the hatchery) surpassing the Lowest Effect Level of 120 mg/Kg. However, these concentrations were much less than the Severe Effect Level for zinc of 820 mg/Kg. These results indicate that, although sediment metal concentrations sometimes exceeded the Lowest

Effect Levels, they were much less than the Severe Effect Levels, and probably do not pose a severe threat to fish and benthos.

The Ontario guidelines did not include effect levels for aluminum, so sediment concentrations from the Red River drainage were compared to results from another study. In the lower Rio Grande Valley and Laguna Atascosa National Wildlife Refuge, Texas, sediment concentrations of aluminum ranged from 940 to 20,000 mg/Kg, which were within the baseline concentrations for soils in the western conterminous United States (Wells *et al.* 1988). Sediment concentrations in the Red River drainage ranged from 1,820 to 5,360 mg/Kg, with the higher levels from the tributaries and the upstream reference sites. All of these concentrations were within the range reported from Texas, and within baseline concentrations for the western U.S.

For aluminum, cadmium, copper, and lead, there were no clear longitudinal trends along the length of the Red River. Also, there were no significant relationships between benthic invertebrate population parameters, and the sediment concentrations of these metals (regression analysis, 95% level of significance). However, zinc concentrations do show a clear longitudinal trend along the Red River (Fig. 7). This trend appears to correspond with a decreasing trend in number of invertebrate taxa in the Red River (Fig. 6). The correlation between these two parameters was not significant at the 95% level, but would be significant at a 90% level ($p = 0.08$). This suggests that sediment levels of zinc may have some effect on populations of benthic invertebrates in the Red River.

RECENT TRENDS IN AQUATIC BIOTA

Fish

Fish population sampling data from the fall of 1997, 1998, and 1999 collected by CEC and data collected in August 1997 by NMDGF (1997) can be compared to evaluate year-to-year variability in fish populations. Resident trout data from spring 1997 collected by CEC are not included as these data are probably not directly comparable to data collected in fall. The presence of YOY fish tends to result in a seasonal trend of more fish being collected in fall than in spring of any given year. Also, the two additional sites sampled in 1999 as part of the TMDL study are not included, as there are no corresponding data from these sites from previous years.

The resident trout data from 1997, 1998, and 1999 exhibit nearly identical trends (Figs. 8, 9). Both density and biomass data vary quite a bit over the length of the Red River. The variability suggests three areas of impacts resulting in decreases in trout density and biomass. Impacts appear to be occurring near the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon (Figs. 8, 9). Highest biomass of trout in all three years occurred at the Elephant Rock Campground site (Fig. 9). Downstream of Hansen Creek, the impacts result in substantial reductions in biomass. The high biomass found at Elephant Rock Campground is not matched again at any site along the remainder of the Red River, in any year (Fig. 9). Decreased habitat quality (i.e., less pool and run area) or poor water quality below the town of Red River and below Hansen Creek could be related to decreased trout populations in these sections (Figs. 4, 5).

Lowest density and biomass occurs at the Questa Ranger Station Site in all three years with CEC and NMDGF data (Figs. 8, 9). This site is downstream of Capulin Canyon and Capulin Springs. Density and biomass recover at the site upstream of the fish hatchery, probably due, in part, to the input of relatively clean water from Cabresto Creek. However, the recovery in fish populations does not reach the high levels of trout density and biomass present at Elephant Rock Campground.

Year-to-year variability in trout populations is common in the western U.S. (Hall and Knight 1981, Platts and Nelson 1988, Scarnecchia and Bergersen 1987). Based on data for 1997 and 1998 in the Red River, we attributed at least some of the variability in trout populations to variability in flow conditions from year to year (CEC 1999). There is frequently an inverse relationship between the timing and magnitude of spring snowmelt runoff flows and fish density (McCullough 1997, Pearsons *et al.* 1992). In years of lower spring runoff, trout generally exhibit higher density and biomass. This has been attributed to the vulnerability of trout fry to displacement during years with higher than normal spring runoff (Anderson and Nehring 1985). At seven of the eight sites sampled on the Red River in 1998, resident fish density and biomass were higher than in 1997 (Figs. 8, 9). We attributed this to the fact that in 1998, spring runoff was relatively low. USGS gaging records at the Questa gage (Fig. 1) indicate that peak daily flow was only 139 cfs in May and June 1998. In contrast, average peak daily flow over a 31-year period (1958-1988) is 209 cfs, and peak daily flow during runoff in

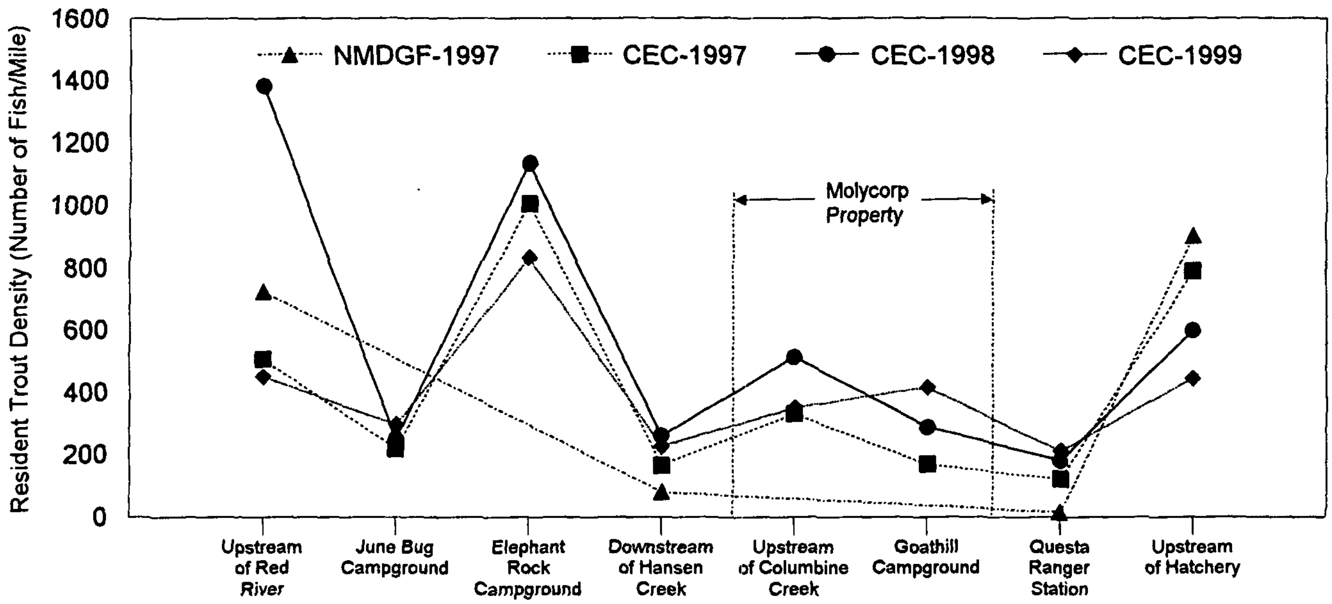

FIGURE 8: Comparison of resident trout density (number per mile) for CEC data collected in fall 1997, 1998, and 1999 and data from August 1997 collected in NMDGF. Data represents results from all electrofishing passing

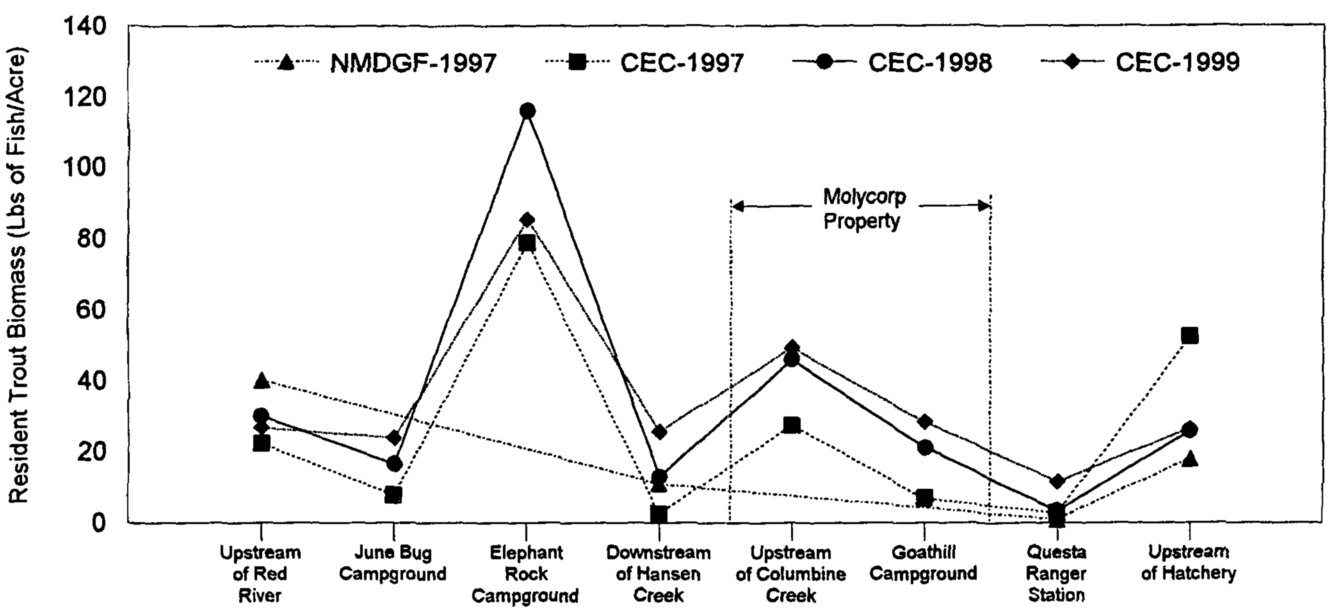

FIGURE 9: Comparison of resident trout biomass (pounds per acre) for CEC data collected in fall 1997, 1998, and 1999 and data from August 1997 collected by NMDGF. Data represents results from all electrofishing passes.

1997 was 347 cfs. The low runoff year in 1998 appears to have allowed trout density and biomass to increase at most locations in the Red River.

This pattern did not hold very well for resident trout density and biomass in 1999. Runoff flows were above the 31-year average (209 cfs) in 1999, with a peak flow of 288 cfs during runoff in late May 1999 (USGS unpubl. flow records). Based on the pattern identified in 1997 and 1998, the relatively high flows in 1999 should have resulted in lower trout density and biomass in 1999. At three of the eight sites, density was lower in 1999, and at only one of the eight sites, biomass was lower in 1999. However, at most sites, density and biomass were similar to or greater in 1999 than in 1998 (Figs. 8, 9).

The number of YOY resident trout does appear to vary with peak flows in the Red River. There were lower numbers of YOY collected at the eight sites on the Red River in 1997 and 1999; many more were collected in 1998 (Table 8). YOY fish were defined as fish less than 90 mm. The number of YOY represents all resident trout (brook trout, brown trout, cutthroat trout, and hybrid trout) collected at the corresponding sites. Site lengths varied between years, but not substantially. This catch pattern seems to be inversely related to peak runoff flow (Table 8). In the two years with relatively high runoff flows, there were fewer young trout; and in 1998, when runoff flows were substantially below average, the number of trout fry was much higher at the Red River sites. Although we have no flow records for the tributaries, assuming the flow years followed the same pattern in these two streams, the YOY catch pattern is not as strong in these streams.

The implications of this pattern is that there may be a time lag between high flow years and resulting lower density and biomass of trout in future years. A single wet or dry year and resulting year-class strength may have little effect on the variability of trout density and biomass on any single year in the long term as other important factors may have a greater effect. However, a few consecutive wet years could result in several consecutive poor year-classes of trout and lower density and biomass in the future. Consequently, several dry years may result in relatively high density and biomass.

TABLE 8: Number of young-of-the-year (≤ 90 mm) resident trout collected during electrofishing at study sites on the Red River and tributaries, 1997-1999, and peak runoff flow data.

Site	1997	1998	1999
Middle Fork, Red River			
Upstream of Town of Red River	7	41	4
June Bug Campground	0	1	0
Downstream Elephant Rock Campground, upstream of Hansen Creek	3	10	3
Downstream of Hansen Creek, upstream of mill	7	7	0
Downstream of mill, upstream of Columbine Creek	0	8	0
Goathill Campground	0	3	2
Upstream of Questa Ranger Station	7	5	2
Upstream of hatchery diversion	6	5	3
Total	**30**	**80**	**14**
Tributaries			
Columbine Creek	5	7	10
Cabresto Creek	26	24	22
Total	**31**	**31**	**22**
Peak Runoff Flow (cfs)	**347**	**139**	**288**
Average Peak Runoff Flow 1958-1988 (cfs)	**209**	**209**	**209**

Benthic Invertebrates

Benthic invertebrate data from fall 1999, fall 1998, fall 1997 (CEC 1998, 1999) and early winter 1995 (Woodward Clyde 1996) are compared to evaluate year-to-year variability in invertebrate populations. The year-to-year variability appears to be much greater for benthic invertebrate population parameters than for fish parameters (Figs. 10, 11).

The trends in all four years are generally consistent, with reduced density and number of taxa downstream of the town of Red River and Hansen Creek, reaching a minimum at the Questa Ranger Station site (Figs. 10, 11). This site is downstream of the confluence with Capulin Canyon and Capulin Springs. This site consistently represents the most impacted section of the Red River. A trend of low benthic invertebrate population parameters was also found in this section of the river by Jacobi *et al.* (1998).

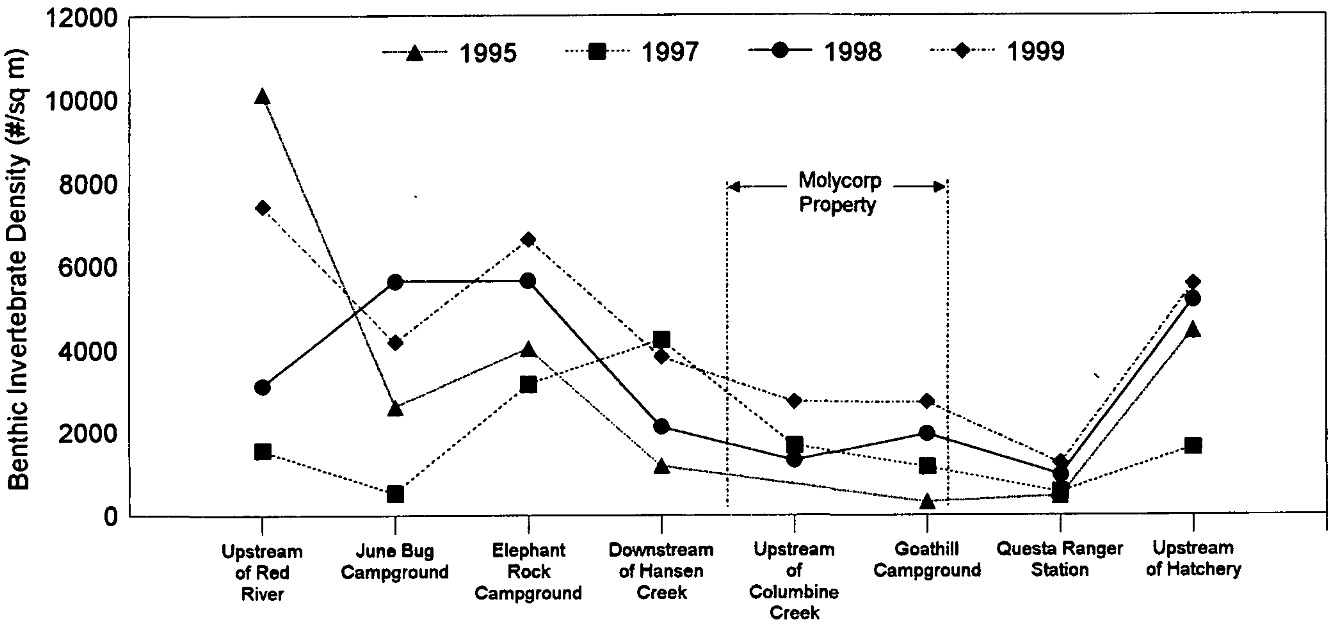

FIGURE 10: Comparison of benthic invertebrate density (number per m^2) for data collected by CEC in fall 1997, fall 1998, and fall 1999, and at corresponding sites by NMED in December 1995.

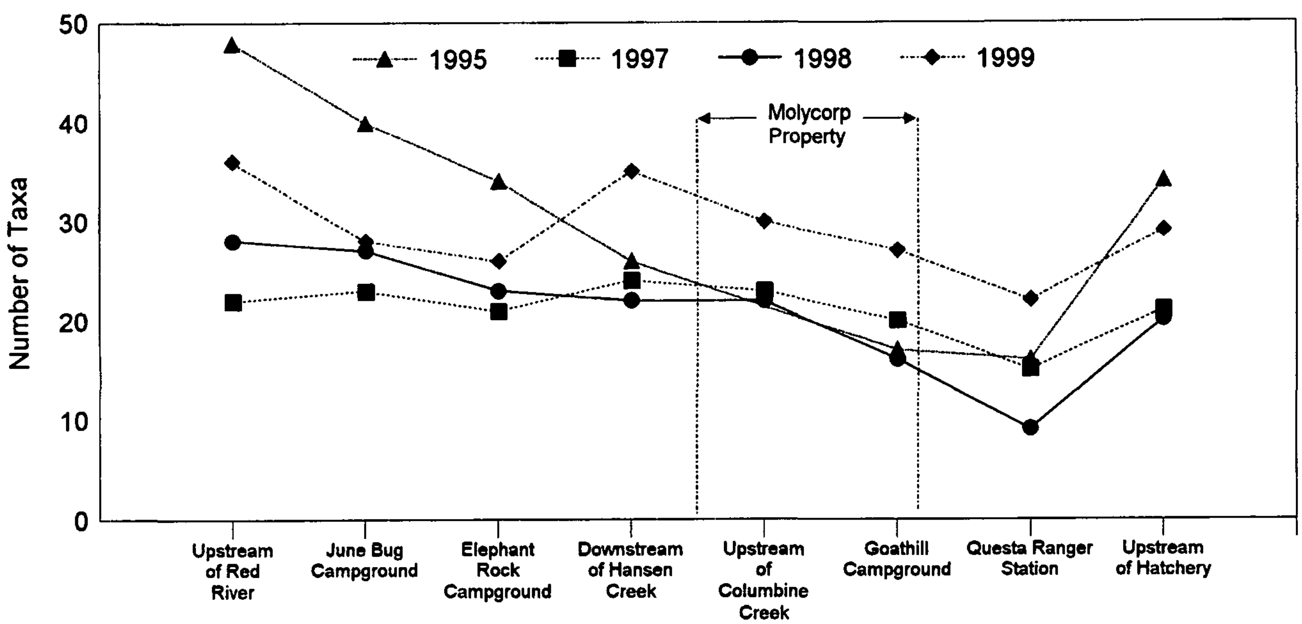

FIGURE 11: Comparison of benthic invertebrate number of taxa for data collected by CEC in fall 1997, fall 1998, and fall 1999, and at corresponding sites by NMED in December 1995.

The trends in all four years are also consistent in exhibiting substantial recovery at the site upstream of the fish hatchery. This site is downstream of the confluence with Cabresto Creek. Apparently, the recovery pattern is enhanced by dilution water from Cabresto Creek, which allows the benthic invertebrate populations to recover to levels comparable to those found in the reaches of the Red River upstream of Hansen Creek. This trend was also demonstrated in Jacobi *et al.* (1998).

During three of the four years, including 1999, there was a substantial decrease in density downstream of Hansen Creek as compared to the site immediately upstream (Fig. 10). There was no corresponding sharp decrease in number of taxa (Fig. 11). Impacts that affect density appear to be occurring in some years; however, the fact that density was relatively high at this site in 1997 suggests that these impacts may be alleviated in other years.

During three of the four years, (1995, 1997, 1999) density was relatively low at the June Bug Campground site, just downstream of the town of Red River (Fig. 10). The number of taxa present at that site was not reduced (Fig. 11). As with Hansen Creek, it appears that the section of the river near the town of Red River may be experiencing impacts. However, the low density years correspond to the years with higher runoff flows. These flows may explain some of the variation in density from year to year.

One of the reference sites, the site upstream of the town of Red River, also had relatively low density during two of the four years (1997, 1998). This variability cannot be explained by variations in peak runoff flows during these years. During 1995 and 1997, peak runoff flows were nearly identical (359 cfs and 347 cfs, respectively) and were also relatively high in 1999 (288 cfs); in 1998, flows were much lower, 139 cfs.

The number of taxa present at this site, and the two other sites upstream of Hansen Creek, was substantially higher in 1995 than in 1997,1998, or 1999 (Fig. 11). This also cannot be explained by variation in flow, and may suggest the possibility of recent impacts influencing this section of the river since 1995. At four of the five sites downstream of Hansen Creek, the number of taxa present in 1999 was higher than in all previous years.

HISTORICAL TRENDS IN AQUATIC BIOTA

Fish

The longitudinal pattern of fish density in Figure 12 is plotted for three different time periods. Data from 1960 were collected prior to the initiation of open pit mining, and represent baseline data. Present conditions are represented by data collected in fall 1997, 1998, and 1999 by CEC and in August 1997 by NMDGF. Data collected during the intervening period of open pit mine operation (1974-1988) are also plotted.

As in past reports (CEC 1997, 1998, 1999), in order to make the data sets for the four periods comparable, only first-pass electrofishing data were used, since this was the primary sampling method used during the earlier studies. Also, since rainbow trout are largely maintained by stocking, and are not as directly controlled by habitat and water quality conditions as are resident fish, rainbow trout numbers have been omitted from the comparison. Lastly, since most of the historic data only present density data, comparison with biomass could not be made.

As stated in our past reports (CEC 1997, 1998, 1999), data collection techniques over the years have varied in methods used and efficiency of collecting fish. This makes direct comparisons between the three different historical periods more difficult. However, assuming that the methods and sampling efficiencies were at least consistent within each historical time period, comparisons of the longitudinal trends are reasonable.

The longitudinal trends in fish density (number of fish/mile) are similar during all three time periods. The trends all indicate relatively high fish density upstream of the town of Red River, decreasing density downstream of Hansen Creek, and increasing density downstream of Questa (Fig. 12). This trend holds for baseline conditions (1960 data), during the intervening period of open pit mine operation (1974-1988), and present conditions (spring, summer, and fall 1997, fall 1998, and fall 1999 data). These are the same trends identified in our earlier reports (CEC 1997, 1998, 1999).

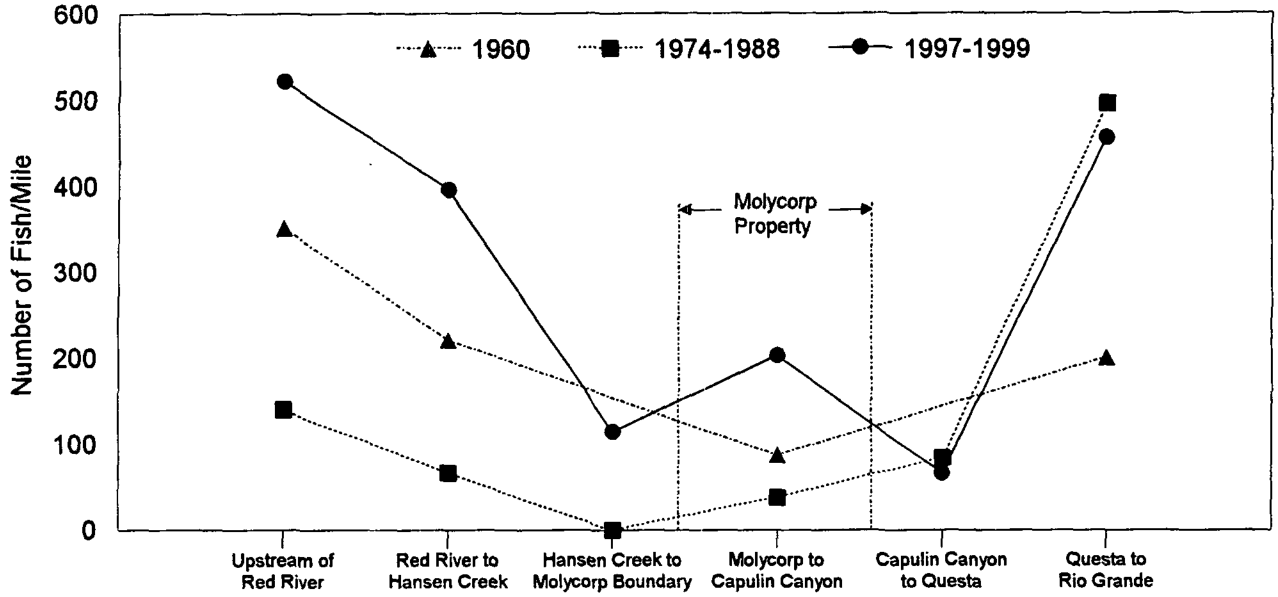

FIGURE 12: Longitudinal trends in fish density (#/mile) for baseline conditions (1960 data), open pit mine operation (1974-1988 data), and present conditions (1997-1999). First pass data only, rainbow trout excluded

The trends in trout density in all three periods indicate that impacts are occurring to the suitability of the Red River to support trout near the town of Red River. The trend in trout density in all three periods also indicate further impacts to trout downstream of Hansen Creek (Fig. 12). Downstream of Hansen Creek and through the section of the Red River adjacent to the Molycorp property, trout density remains low. During all three sampling periods, there was also a substantial increase in resident trout density in the reach of the Red River downstream of Questa. In this lower reach of the river, trout density returned to levels comparable to or higher than those found in the reach upstream of the town of Red River (Fig. 12). As stated previously, these longitudinal patterns in fish abundance could, in part, be related to habitat differences (i.e., amount of pools and runs) between sites. However, there are probably other factors (e.g., water quality) also closely related to fish abundance at some sites.

Benthic Invertebrates

For benthic invertebrates, the collected data also were divided into three time periods. Baseline conditions were represented by data collected in 1965, apparently prior to the initiation of open pit mining. Benthic invertebrate data collected in 1995, fall 1997, fall 1998, and fall 1999 represent present conditions. Data available from the intervening period (1970-1992) represent conditions during open pit mining.

Comparisons are made between the two population parameters of density (#/m^2) and number of taxa. As with the historical fish data, techniques for sampling and analyzing invertebrates may have varied between the periods, making direct comparisons over time difficult. However, assuming similar techniques were employed within each historical time period, comparisons of the downstream trends are reasonable.

The longitudinal trends in density for the three sampling periods (1965, 1970-1992, and 1995-1999) show a similar pattern of decreasing density downstream from the headwaters of the Red River, with low densities of benthic invertebrates downstream of Hansen Creek (Fig. 13). In the remainder of the Red River from the Molycorp property downstream past Questa, the data from the three sampling periods also have a similar trend (Fig 13). Low densities continue to occur adjacent to the Molycorp Mine, and lowest densities are found near the Questa Ranger Station in the reach of the river downstream of Capulin Canyon. This is followed by an increase in density in the reach downstream of Questa, after Cabresto Creek inputs relatively clean water into the Red River. This general trend has not changed since 1965. These are the same trends identified in our earlier reports (CEC 1997, 1998, 1999).

The trend in number of taxa for three sampling periods (1965, 1970-1992, and 1995-1999) indicates a gradual decrease in taxa along the length of the Red River to the reach downstream of Capulin Canyon (Fig. 14). This is followed by an increase in number of taxa downstream of Questa for two of these periods (1970-1992, 1995-1999).

In all six reaches for data collected in 1995-1999, densities and number of taxa are substantially higher than during the baseline period (1965) and the period of open pit and underground mine operation (Figs. 13, 14). As mentioned in our earlier reports, this may be partly due to different methods of data collection and analysis. However, these data indicate that the Red River is at least as suitable for sustaining benthic invertebrates at present as it was prior to the initiation of open pit mine operations.

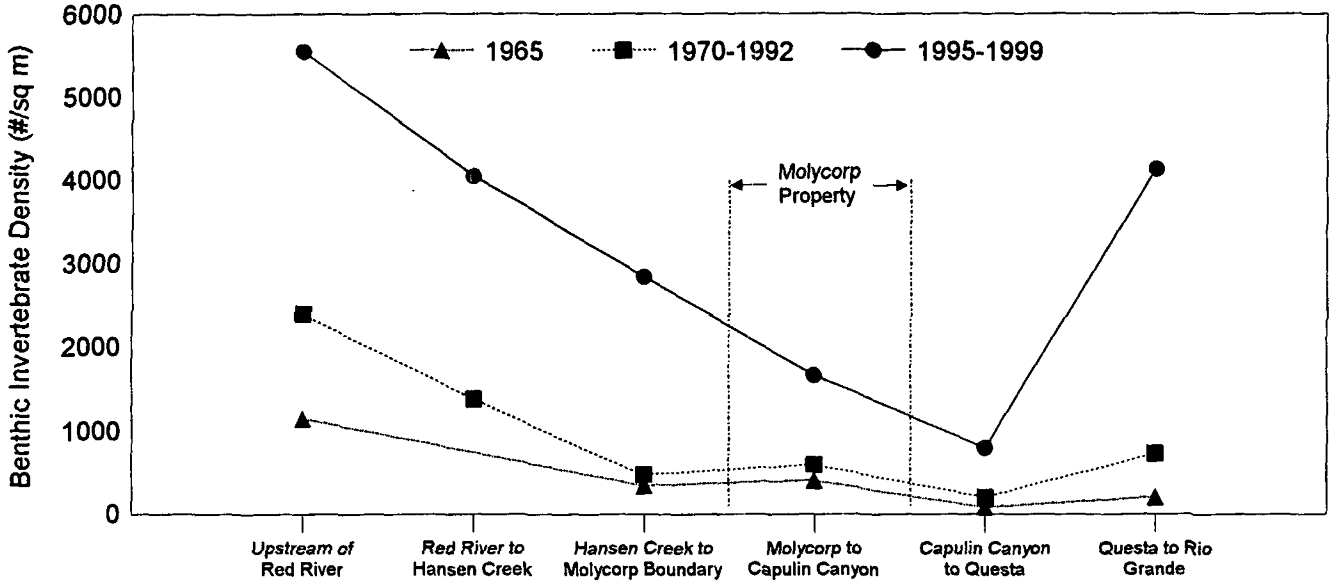

FIGURE 13: Longitudinal trends in benthic invertebrate density (#/m^2) for baseline conditions (1965 data), open pit mine operation (1970-1992 data), and present conditions (fall 1995, fall 1997, fall 1998, and fall 1999 data).

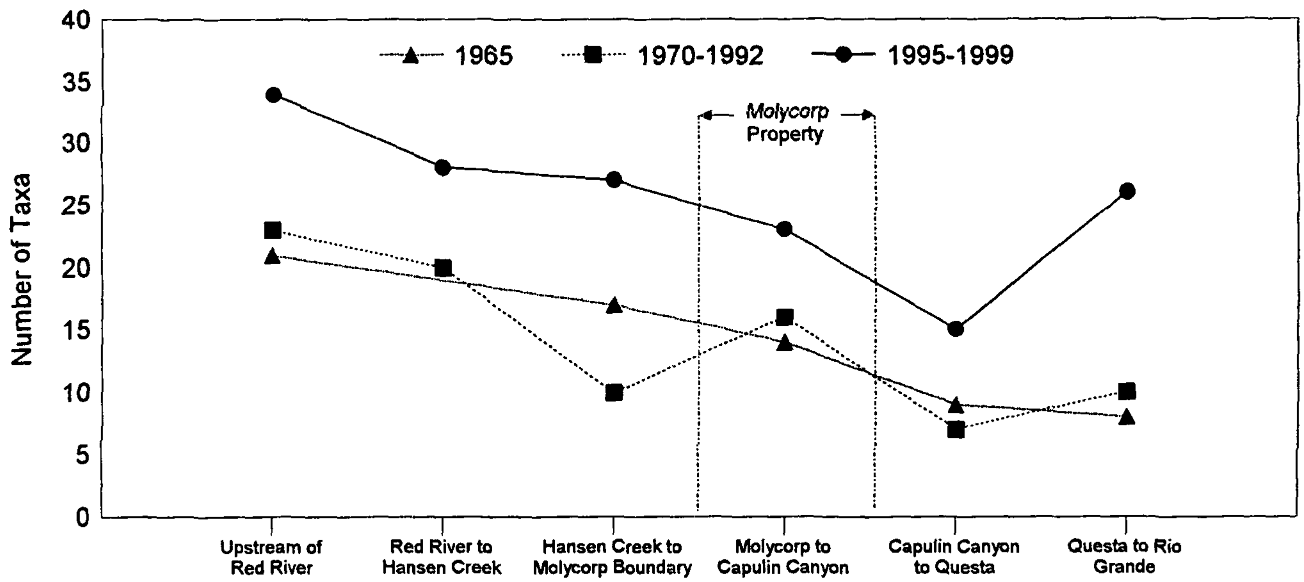

FIGURE 14: Longitudinal trends in number of benthic invertebrate taxa for baseline conditions (1965 data), open pit mine operation (1970-1992 data), and present conditions (fall 1995, fall 1997, fall 1998, and fall 1999 data).

CONCLUSIONS

The lower reaches of the Red River, especially the sections adjacent to the Molycorp Mine downstream to Questa, have been referred to as biologically impoverished, devoid of aquatic life, or even a biological desert. This is not true. Data for 1999 indicate the presence of resident populations of fish and macroinvertebrates at all sites along the length of the Red River. At the most impacted site on the river, the site at the Questa Ranger Station downstream of Capulin Canyon, 22 species of the benthic macroinvertebrates and three species of fish were present in 1999. There were no sections of the Red River that were severely impacted to the point of biological impoverishment. There seems to be multiple areas and pathways (chemical, physical) of minor to moderate impacts along the river that affect fish and invertebrates to varying degrees. The fact that these impacts do not reduce the Red River to a biological desert, and the fact that multiple species of fish and invertebrates, including sensitive species, are present along the length of the Red River tend to make interpretation of the data more difficult.

Our previous reports (CEC 1997, 1998, 1999) concluded that the primary impacts to the suitability of the Red River to sustain aquatic biota were occurring near the town of Red River, downstream of Hansen Creek and downstream of Capulin Canyon (CEC 1997). Downstream of the confluence of Cabresto Creek, conditions improved for both fish and benthic invertebrates. The cause of these impacts appeared to be the input of excess sediment from a number of sources and decreased water quality, especially at locations receiving drainage from hydrothermal scars. Those reports further concluded that baseline data indicated these impacts were present prior to the initiation of open pit mining at the Molycorp Questa Mine, and in reaches of the Red River upstream of the mine. Those reports also concluded that present population levels of fish and benthic invertebrates are higher than during baseline conditions, suggesting that there have been improvements in the suitability of the Red River to support aquatic biota since the 1960s (CEC 1997).

In 1999, habitat data indicated that riffles and runs dominated habitat types at all study sites, which is not unusual for mountain streams. Pools comprised a small proportion of the overall habitat. Various types of cover, including undercut banks, water deeper than 2 ft, pocket water, and woody debris, were present in different combinations at all study sites. No clear longitudinal pattern was observed in overall habitat quality between sites.

Resident trout populations in each year from 1997-1999 showed similar trends, indicating three areas of impact resulting in decreases in trout abundance. Impacts appear to be occurring downstream of the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon. The trout data collected in fall 1999 exhibit nearly the same longitudinal trend in density as that found for baseline conditions (1960) and the period of open pit operation (1974-1988). The most recent density and biomass data from fall 1999 support the conclusions of our previous reports; the trends have not changed.

Multiple regression analysis indicated that there were statistically significant, but weak, relationships between the amount of pool and run habitat and trout density and biomass in 1999. As the amount of pool and run habitat increased, so did trout abundance. This relationship was especially poor at explaining the trout density and biomass at the Questa Ranger Station and downstream of the fish hatchery. This indicates that variations in trout populations are also due to some other factor, such as water quality or streambed sediment.

The trends in benthic invertebrate population parameters from data collected in the fall of 1999 were similar to the trends from the baseline (1965) and open pit mine operation periods (1970-1992). Density data indicates impacts near the town of Red River, downstream of Hansen Creek and downstream of Capulin Canyon. All three data sets indicate increasing density at sites downstream of Questa. Trends in the number of taxa are more gradual than for density. Data from all three periods indicate a general decrease in the number of benthic invertebrate taxa from upstream of Red River downstream to the site near the Questa Ranger Station, downstream of Capulin Canyon.

At all sites along the river, including the sites in the most impacted reaches, numerous species of sensitive EPT taxa are present. This includes several species of mayflies, which are especially sensitive to metals impacts, as well as more tolerant caddisfly species. This indicates that the impacts occurring along the length of the Red River are not severe, and the river is suitable for sustaining sensitive invertebrate species along its entire length.

Benthic invertebrate data for 1995, 1997, 1998, and 1999 indicate similar patterns in the downstream reaches of the Red River. In the upstream reaches of the river, population parameters seem to be more variable from year to year.

Sediment concentrations of metals were compared to sediment quality guidelines from Ontario, and to another sediment study. Sediment concentrations of copper, lead, and zinc in the Red River sometimes exceeded the Lowest Effect Level, but not by much, and were always much less than the Severe Effect Level. Aluminum concentrations in the Red River were comparable to those in a wildlife refuge in Texas, and within baseline concentrations from the western U.S.

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APPENDIX A

Habitat Data

1

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-15-99

Site: Middle Fk

Comments: TB, MS

Page: 1 of 2

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	Run	LGR	Run	HGR	Run	Run	Run	LGR
LENGTH (ft)	35	14	26	30	24	7	16	22
WETTED WIDTH (ft)	9	9	9	10	8	8	6	13
MAXIMUM DEPTH (ft)	0.9	0.6	1.1	0.9	0.9	0.8	1.1	0.5
AVERAGE DEPTH (ft)	0.4	0.4	0.7	0.5	0.5	0.5	0.6	0.3
ERODING BANK (ft)	0	0	0	0	0	0	0	0

COVER

UNDERCUT BANKS (ft^2)	0	0	0	0	0	0	4	0
WATER >2 ft DEEP (ft^2)	0	0	0	0	0	0	0	0
POCKET WATER (ft^2)	2	3	0	7	2	3	8	3
ROOT WADS (ft^2)	0	0	0	0	0	0	0	0
WOODY DEBRIS (ft^2)	0	0	5	0	0	0	0	0
OVERHANGING VEG. (ft^2)	7	0	0	0	3	0	0	0
CUT BANK (ft^2)	3	0	0	0	0	0	0	0

CANOPY COVER (%)	90	70	75	40	90	85	60	60

RUN- Run
LGR- Low Gradient Riffle
HGR- High Gradient Riffle

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-15-99

Site: Middle Fk

Comments: TB, MS

Page: 2 of 2

HABITAT UNIT #	~~[illegible]~~ 9	10	11	12				
TYPE	MCP	LGR	MCP					
LENGTH (ft)	18	47	9					
WETTED WIDTH (ft)	12	9	8					
MAXIMUM DEPTH (ft)	2	0.8	1.2					
AVERAGE DEPTH (ft)	1	0.5	0.8					
ERODING BANK (ft)	L 18 R 0	0	0					

COVER

UNDERCUT BANKS (ft^2)	0	0	6					
WATER >2 ft DEEP (ft^2)	0	0	0					
POCKET WATER (ft^2)	0	2	24					
ROOT WADS (ft^2)	0	0	0					
WOODY DEBRIS (ft^2)	30	0	0					
OVERHANGING VEG. (ft^2)	0	0	0					
CUT BANK (ft^2)	0	0	0					

CANOPY COVER (%)	5	65	65					
L. Left Side looking upstream	Log Pluge Pool	Small trib. coming in						
R. Right Side Looking Upstream								

MCP. Mid Channel Pool
LGR. Low Gradient Riffle
Run. Run

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-~~14~~ 15-99

Site: Above Red River

Comments: TB, DC

Page: 1 of 2

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	RUN	LGR	RUN	LGR	RUN	RUN	LGR	RUN
LENGTH (ft)	21	55	25	40	41	40	20	21
WETTED WIDTH (ft)	21	21	21	18	18	16	16	12
MAXIMUM DEPTH (ft)	1.2	1.0	2.2	1.0	1.2	1.7	1.0	1.3
AVERAGE DEPTH (ft)	0.7	0.5	1.0	0.5	0.7	1.0	0.7	0.8
ERODING BANK (ft)	0	0	0	0	0	0	0	0

COVER

UNDERCUT BANKS (ft^2)	0	5	0	0	0	15	0	0
WATER >2 ft DEEP (ft^2)	0	0	10	0	0	0	0	0
POCKET WATER (ft^2)	0	0	12	2	6	10	4	2
ROOT WADS (ft^2)	0	0	0	0	0	0	0	0
WOODY DEBRIS (ft^2)	0	0	0	0	20	9	0	0
OVERHANGING VEG. (ft^2)	0	0	0	0	0	0	0	0
CUT BANK (ft^2)	0	0	12	0	0	0	0	0

CANOPY COVER (%)	15	10	5	5	15	35	50	20
			Nice Boulder Pool in this Section					

RUN- Run
LGR- Low Gradient Riffle

4

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER

Date: 9-15-99

Site: Above Red River

Comments: TB, DC

Page: 2 of 2

HABITAT UNIT #	9	10						
TYPE	LGR	RUN						
LENGTH (ft)	115	43						
WETTED WIDTH (ft)	22	19						
MAXIMUM DEPTH (ft)	1.0	1.8						
AVERAGE DEPTH (ft)	0.5	1.0						
ERODING BANK (ft)	0	0						

COVER

UNDERCUT BANKS (ft^2)	0	10						
WATER >2 ft DEEP (ft^2)	0	0						
POCKET WATER (ft^2)	12	0						
ROOT WADS (ft^2)	0	20						
WOODY DEBRIS (ft^2)	0	32						
OVERHANGING VEG. (ft^2)	0	0						
CUT BANK (ft^2)	10	0						

CANOPY COVER (%)	30	40						

LGR - Low Gradient Riffle
RUN - Run

(5)

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER

Date: 9-15-99

Site: JUNEBUG CAMPGROUND

Comments: TB

Page: 1 OF 1

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	HGR	MCP	RUN	HGR	LGR	RUN		
LENGTH (ft)	97	16	14	95	67	50		
WETTED WIDTH (ft)	18	18	19	21	17	12		
MAXIMUM DEPTH (ft)	1.5	1.4	1.6	1.1	1.3	2.5		
AVERAGE DEPTH (ft)	0.7	1.0	0.8	0.6	0.8	1.2		
ERODING BANK (ft)	L-0 R-97	L-16 R-0	L-14 R-0	L-0 R-30	L-0 R-67	L-0 R-30		

COVER

UNDERCUT BANKS (ft^2)	0	0	0	0	~~40~~ ~~45~~ 85	90		
WATER >2 ft DEEP (ft^2)	0	0	0	0	0	18		
POCKET WATER (ft^2)	77	6	0	63	15	0		
ROOT WADS (ft^2)	0	0	0	0	0	0		
WOODY DEBRIS (ft^2)	0	0	0	4	0	0		
OVERHANGING VEG. (ft^2)	0	0	0	0	0	0		
CUT BANK (ft^2)	0	0	0	0	0	0		

CANOPY COVER (%)	10%	5%	5%	10%	30%			

L · Left Side of Bank Looking Upstream

R · Right Side of Bank Looking Upstream

HGR · High Gradient Riffle

LGR · Low Gradient Riffle

MCP · Mid Channel Pool

RUN · Run

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-16-99

Site: Below Elephant Rock Campground

Comments: TB, DC

Page: 1 of 1

HABITAT UNIT #	1	2	3	4	5	6		
TYPE	RUN	LGR	RUN	HGR	RUN	LGR		
LENGTH (ft)	43	64	27	54	83	21		
WETTED WIDTH (ft)	21	24	18	18	15	20		
MAXIMUM DEPTH (ft)	1.5	1.1	1.6	1.6	2.6	1.2		
AVERAGE DEPTH (ft)	0.6	0.7	0.9	0.8	1.6	0.6		
ERODING BANK (ft)	L-17 R-0	L-22 R-0	L-2 R-0	L-18 R-0	L-9 R-0	0		

COVER

UNDERCUT BANKS (ft^2)	18	59	0	0	60	0		
WATER >2 ft DEEP (ft^2)	0	0	0	0	14	0		
POCKET WATER (ft^2)	0	0	2	43	0	0		
ROOT WADS (ft^2)	0	0	0	0	0	0		
WOODY DEBRIS (ft^2)	0	0	0	0	0	10		
OVERHANGING VEG. (ft^2)	0	0	0	0	15	0		
CUT BANK (ft^2)	10	0	8	0	28	0		

CANOPY COVER (%)	5	10	5	25	10	0		

L- Left Side looking Upstream
R- Right Side looking Upstream
RUN- Run
LGR- Low Gradient Riffle
HGR- High Gradient Riffle

(7)

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-16-99

Site: Below Hansen Ck.

Comments: TB, DC

Page: 1 of 1

Not much spawning or juvenile habitat

HABITAT UNIT #	1	2	3	4	5	6		
TYPE	RUN	LGR	RUN	LGR				
LENGTH (ft)	27	56	75	170				
WETTED WIDTH (ft)	17	18	14	20				
MAXIMUM DEPTH (ft)	1.6	1.3	1.5	1.6				
AVERAGE DEPTH (ft)	1.2	0.8	1.1	0.8				
ERODING BANK (ft)	0	0	L-4 R-8	L-20 R-30				

COVER

UNDERCUT BANKS (ft²)	0	0	0	0				
WATER >2 ft DEEP (ft²)	0	0	0	0				
POCKET WATER (ft²)	7	10	7	27				
ROOT WADS (ft²)	0	0	0	0				
WOODY DEBRIS (ft²)	0	0	0	0				
OVERHANGING VEG. (ft²)	0	0	0	0				
CUT BANK (ft²)	0	0	40	0				

CANOPY COVER (%)	30	60	60	25				

L- Left side of bank looking upstream

R- Right side of bank looking upstream

LGR- Low Gradient Riffle

RUN- Run

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER

Date: 9-16-99

Site: Above Coulmbine Below Mill

Comments: TB, DC

Page: 1 of 1

HABITAT UNIT #	1	2	3	4	5			
TYPE	HGR	RUN	HGR	RUN	HGR			
LENGTH (ft)	78	53	46	40	71			
WETTED WIDTH (ft)	15	19	17	16	17			
MAXIMUM DEPTH (ft)	1.3	1.8	1.6	1.8	1.8			
AVERAGE DEPTH (ft)	0.8	1.1	1.0	1.3	1.1			
ERODING BANK (ft)	L-16 R-58	L-0 R-53	L-46 R-46	L-40 R-0	L-47 R-0			

COVER

UNDERCUT BANKS (ft^2)	0	0	0	0	0			
WATER >2 ft DEEP (ft^2)	0	0	0	0	0			
POCKET WATER (ft^2)	19	2	30	6	45			
ROOT WADS (ft^2)	0	0	14	0	0			
WOODY DEBRIS (ft^2)	0	0	0	5	12			
OVERHANGING VEG. (ft^2)	0	0	0	0	4			
CUT BANK (ft^2)	0	0	0	0	0			

CANOPY COVER (%)	30	15	5	5	30			
L- Left Bank Looking Upstream								
R - Right Bank Looking Upstream								

HGR- High Gradient Riffle
RUN- Run

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER

Date: 9-13-99

Site: GOAT HILL CAMPGROUND

Page: 1 of 2

Comments: TB, DC Lots of pocket water in riffles

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	HGR	RUN	MCP	HGR	LGR	MCP	LGR	HGR
LENGTH (ft)	58	25	18	41	38	15	47	37
WETTED WIDTH (ft)	20	16	12	30	21	16	18	25
MAXIMUM DEPTH (ft)	1.5	2.0	2.2	1.2	1.8	1.8	2.0	1.8
AVERAGE DEPTH (ft)	1.1	1.2	1.3	0.8	1.2	1.2	1.1	0.8
ERODING BANK (ft)	L- 15 R- 20	L - 10 R - 0	L - 6 R - 0	L - 10 R - 0	L - 6 R - 0	0	L - 23 R - 15	L - 37 R - 32

COVER

UNDERCUT BANKS (ft^2)	Ø	18	0	0	0	0	0	10
WATER >2 ft DEEP (ft^2)	0	0	0	0	0	0	0	0
POCKET WATER (ft^2)	25	60	24	33	42	32	9	12
ROOT WADS (ft^2)	0	0	0	0	0	0	0	0
WOODY DEBRIS (ft^2)	20	0	0	0	0	0	0	0
OVERHANGING VEG. (ft^2)	0	0	0	0	0	0	0	0
CUT BANK (ft^2)	0	0	0	0	0	0	0	0

CANOPY COVER (%)	30	20	15	15	20	30	25	20

L- Left Side Looking Upstream

R- Right Side Looking Upstream

LGR- Low Gradient Riffle

HGR- High Gradient Riffle

RUN- Run

MCP- Mid Channel Pool

Lots of juvinile habitat present on left bank

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-13-99

Site: GOAT HILL CAMPGROUND

Page: 2 of 2

Comments: TB, DC

HABITAT UNIT #	9	10						
TYPE	RUN	HGR						
LENGTH (ft)	63	90						
WETTED WIDTH (ft)	16	22						
MAXIMUM DEPTH (ft)	1.8	1.4						
AVERAGE DEPTH (ft)	1.1	1.0						
ERODING BANK (ft)	L - 5 R - 63	L - 0 R - 85						

COVER

UNDERCUT BANKS (ft^2)	0	0						
WATER >2 ft DEEP (ft^2)	0	0						
POCKET WATER (ft^2)	37	27						
ROOT WADS (ft^2)	0	0						
WOODY DEBRIS (ft^2)	0	0						
OVERHANGING VEG. (ft^2)	0	24						
CUT BANK (ft^2)	0	0						

CANOPY COVER (%)	20	35						

L - Left Side looking Upstream

R - Right Side looking Upstream

RUN - Run

HGR - High Gradient Riffle

Juvinille habitat present or left side

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: Red River

Date: 9-13-99

Site: Above Questa Ranger Station

Comments: TB, DC

Page: 1 of 1

Eroding banks show several tailings layers

* Juvinille Habitat Present @ several locations (1) Backwater (2) Woody Debris Backwater (3) Slackwater

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	LGR	LSP	LGR	RUN	LGR	RUN	MCP	HGR
LENGTH (ft)	90	29	61	101	65	53	16	12
WETTED WIDTH (ft)	23	22	23	19	19	16	15	19
MAXIMUM DEPTH (ft)	1.4	2.0	1.4	1.4	1.8	1.5	2.3	1.7
AVERAGE DEPTH (ft)	0.9	1.1	0.9	0.9	0.8	1.0	1.5	1.0
ERODING BANK (ft)	0	0	0	L- 59 R- 69	L- 65 R- 65	L- 32 R- 53	L- 0 R- 16	L - 0 R - 0

COVER

	1	2	3	4	5	6	7	8
UNDERCUT BANKS (ft^2)	0	50	0	0	0	0	0	0
WATER >2 ft DEEP (ft^2)	0	0	0	0	0	0	35	0
POCKET WATER (ft^2)	10	0	15	9	7	22	8	37
ROOT WADS (ft^2)	0	0	0	0	0	0	0	0
WOODY DEBRIS (ft^2)	0	0	0	3	3 3	0	3	0
OVERHANGING VEG. (ft^2)	0	0	20	0	0	0	0	0
CUT BANK (ft^2)	0	0	0	0	4 7	0	0	0

CANOPY COVER (%)	35	35	20	10	10	10	25	10

L- Left Side Looking Upstream
R- Right Side Looking Upstream

LGR- Low Gradient Riffle
LSP- Laterial Scour Pool
RUN - Run
MCP - Mid Channel Pool
HGR - High Gradient Riffle

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER

Date: 9-14-99

Site: Above Fish Hatchery

Comments: TB, DC

Page: 1 of 1

Spawning gravel & Juvinile Habitat Present

Canopy cover consists mainly of shrubs & willows

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	HGR	MCP	RUN	HGR	MCP	HGR		
LENGTH (ft)	84	15	32	50	30	135		
WETTED WIDTH (ft)	21	20	20	23	18	18		
MAXIMUM DEPTH (ft)	2.2	3.2	2.2	2.2	3.5	3.0		
AVERAGE DEPTH (ft)	1.5	2.0	1.5	1.5	2.2	1.6		
ERODING BANK (ft)	0	0	0	0	0	0		

COVER

UNDERCUT BANKS (ft^2)	0	0	0	0	0	0		
WATER >2 ft DEEP (ft^2)	15	91	8	10	120	80		
POCKET WATER (ft^2)	28	10	15	20	6	95		
ROOT WADS (ft^2)	0	0	0	0	0	0		
WOODY DEBRIS (ft^2)	24	0	0	0	0	0		
OVERHANGING VEG. (ft^2)	0	0	0	0	0	0		
CUT BANK (ft^2)	0	0	0	0	0	0		

CANOPY COVER (%)	10	5	10	5	0	5		

HGR- High Gradient Riffle
MCP- Mid Channel Pool
RUN - Run

13

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: RED RIVER Date: 9-14-99

Site: DOWNSTREAM OF HATCHERY

Comments: TB, DC Page: 1 of 1

Spawning & Juvenille habitat present

South Bank Shaded by Steep Cliff

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	LGR	RUN	HGR	RUN	LGR	LSP	HGR	
LENGTH (ft)	37	88	38	64	78	42	36	
WETTED WIDTH (ft)	36	30	21	17	20	20	27	
MAXIMUM DEPTH (ft)	1.4	2.4	2.5	2.5	2.5	3.6	2.5	
AVERAGE DEPTH (ft)	1.0	1.5	1.7	1.7	1.4	2.0	1.5	
ERODING BANK (ft)	0	0	0	0	0	0	0	

COVER

UNDERCUT BANKS (ft^2)	0	0	0	0	0	0	0	
WATER >2 ft DEEP (ft^2)	0	~~[illegible]~~ 120	50	0	0	75	0	
POCKET WATER (ft^2)	0	6	24	60	45	0	20	
ROOT WADS (ft^2)	0	0	0	0	0	0	0	
WOODY DEBRIS (ft^2)	125	~~140~~ ~~[illegible]~~ 171	0	0	50	0	0	
OVERHANGING VEG. (ft^2)	0	0	0	0	0	0	0	
CUT BANK (ft^2)	0	0	0	0	0	35	0	

CANOPY COVER (%)	15	35	50	15	40	25	10	
				Next to gaging station				

LGR- Low Gradient Riffle

RUN- Run

LSP- Lateral Scour Pool

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: COLUMBINE CK

Date: 9-15-99

Site: @ COLUMBINE CK CAMPGROUND

Comments: TB, DC

Page: 1 of 1

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	MCP	LGR	RUN	LGR	RUN	LGR		
LENGTH (ft)	15	15	25	65	13	151		
WETTED WIDTH (ft)	12	14	13	12	17	11		
MAXIMUM DEPTH (ft)	1.1	0.6	1.1	1.1	0.9	1.5		
AVERAGE DEPTH (ft)	0.7	0.4	0.7	0.6	0.6	0.5		
ERODING BANK (ft)	0	0	0	0	0	0		

COVER

UNDERCUT BANKS (ft^2)	5	0	3	14	0	28		
WATER >2 ft DEEP (ft^2)	0	0	0	0	0	0		
POCKET WATER (ft^2)	0	0	6	6	4	12		
ROOT WADS (ft^2)	0	0	0	0	0	0		
WOODY DEBRIS (ft^2)	0	0	0	0	0	0		
OVERHANGING VEG. (ft^2)	0	0	0	0	0	20		
CUT BANK (ft^2)	0	0	0	0	0	0		

CANOPY COVER (%)	60	40	80	75	70	65		

LGR- Low Gradient Riffle
RUN- Run
MCP- Mid Channel Pool

MOLYCORP FISH HABITAT INVENTORY FORM

Stream: CABRESTO CK　　Date: 9-17-99

Site:

Comments: TB DC　　Page: 1 of 1

Eroding bank is cutting against road

HABITAT UNIT #	1	2	3	4	5	6	7	8
TYPE	MCP	LGR	RUN	RUN	LGR	LSP	LGR	
LENGTH (ft)	11	12	22	18	29	15	186	
WETTED WIDTH (ft)	12	9	9	9	11	12	14	
MAXIMUM DEPTH (ft)	2.1	1.2	1.2	1.0	1.1	1.4	1.1	
AVERAGE DEPTH (ft)	1.5	0.7	0.7	0.5	0.5	0.6	0.6	
ERODING BANK (ft)	L - 11 R - 0	L - 12 R - 0	L - 22 R - 0	L - 18 R - 8	L - 29 R - 0	L - 15 R - 0	0	

COVER

UNDERCUT BANKS (ft^2)	5	0	2	10	12	0	2	
WATER >2 ft DEEP (ft^2)	2	0	0	0	0	0	0	
POCKET WATER (ft^2)	7	3	3	0	0	0	19	
ROOT WADS (ft^2)	0	0	0	0	0	0	0	
WOODY DEBRIS (ft^2)	0	0	0	0	0	27	11	
OVERHANGING VEG. (ft^2)	0	0	6	0	0	0	0	
CUT BANK (ft^2)	0	0	0	0	0	0	0	

CANOPY COVER (%)	70	70	60	70	60	60	85	
L. Left Side Looking Upstream R. Right Side Looking Upstream	Boulder Pool							

LGR - Low Gradient Riffle　　LSP - Laterial Scour Pool

RUN - Run

MCP - Mid Channel Pool

APPENDIX B

Fish Population Data

1

Molycorp
Red River Middle Fork
09/15/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRK	1	218	120	1	1.16	107.4	111.8
BRK	1	213	102	1	1.06	100.1	101.9
BRK	1	210	98	1	1.06	95.8	102.3
BRK	1	205	104	1	1.21	89.1	116.8
BRK	1	203	92	1	1.1	86.4	106.4
BRK	1	197	84	1	1.1	78.9	106.5
BRK	1	190	72	1	1.05	70.7	101.9
BRK	1	190	62	1	0.9	70.7	87.7
BRK	1	189	62	1	0.92	69.5	89.1
BRK	1	186	72	1	1.12	66.2	108.7
BRK	1	185	58	1	0.92	65.2	89.0
BRK	1	182	60	1	1	62.0	96.8
BRK	1	174	46	1	0.87	54.1	85.1
BRK	1	170	56	1	1.14	50.4	111.2
BRK	1	169	50	1	1.04	49.5	101.0
BRK	1	167	41	1	0.88	47.7	85.9
BRK	1	149	31	1	0.94	33.7	91.9
BRK	1	143	32	1	1.09	29.8	107.5
BRK	1	139	27	1	1.01	27.3	98.9
BRK	1	112	14	1	1		
BRK	1	56	1.4	1	0.8		
BRK	1	55	1.6	1	0.96		
BRK	2	187	76	1	1.16	67.3	112.9
BRK	2	54	1.3	1	0.83		
BRK	2	48	1	1	0.9		
RBT	1	294	265	1	1.04	276.2	95.9
RBT	1	277	200	1	0.94	230.7	86.7
RBT	1	244	148	1	1.02	157.2	94.1
RBT	1	237	144	1	1.08	144.0	100.0
RBT	1	231	146	1	1.18	133.2	109.6
RBT	1	226	130	1	1.13	124.7	104.3
RBT	1	150	33	1	0.98		

BRK		LENGTH	WEIGHT	K	Ws	Wr
	N	25	25	25	20	20
	MIN	48	1	0.8	27.3	85.1
	MAX	218	120	1.21	107.4	116.8
	MEAN	159.6	54.6	1.0	66.1	100.7
RBT		**LENGTH**	**WEIGHT**	**K**	**Ws**	**Wr**
	N	7	7	7	6	6
	MIN	150	33	0.94	124.7	86.7
	MAX	294	265	1.18	276.2	109.6
	MEAN	237.0	152.3	1.1	177.7	98.4

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRK	22	3	25	+/- 0.67	0.053	472	56.8
RBT	7	0	7	+/- 0.00	0.053	132	44.3

(2)

Molycorp
Red River Upstream of Red River
09/15/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRK	1	238	156	1	1.16	140.3	111.2
BRK	1	237	136	1	1.02	138.5	98.2
BRK	1	235	146	1	1.12	134.9	108.2
BRK	1	212	105	1	1.1	98.6	106.5
BRK	1	210	101	1	1.09	95.8	105.4
BRK	1	198	91	1	1.17	80.1	113.6
BRK	1	160	38	1	0.93	41.9	90.7
BRK	1	146	29	1	0.93	31.7	91.5
BRK	1	145	29	1	0.95	31.0	93.4
BRK	1	143	28	1	0.96	29.8	94.1
BRK	1	140	25	1	0.91	27.9	89.6
BRK	1	138	25	1	0.95	26.7	93.6
BRK	1	133	22	1	0.94	23.9	92.2
BRK	1	120	18	1	1.04		
BRK	1	74	5	1	1.23		
BRK	1	70	4	1	1.17		
BRK	2	194	62	1	0.85	75.3	82.3
BRK	2	188	86	1	1.29	68.4	125.7
BRK	2	156	42	1	1.11	38.8	108.3
BRK	2	143	27	1	0.92	29.8	90.7
BRK	2	138	23	1	0.88	26.7	86.1
BRK	2	137	28	1	1.09	26.1	107.2
BRK	2	65	2.5	1	0.91		
BRN	1	305	290	1	1.02	304.4	95.3
BRN	1	257	173	1	1.02	183.3	94.4
BRN	1	195	81	1	1.09	80.9	100.1
BRN	1	131	21	1	0.93		
BRN	2	276	201	1	0.96	226.5	88.8
BRN	2	58	2.5	1	1.28		
CUTBOW	1	119	17	1	1.01		
CUTBOW	1	106	12	1	1.01		
CUTBOW	2	170	48	1	0.98		
CUTBOW	2	140	26	1	0.95		
RBT	1	353	450	1	1.02	480.3	93.7
RBT	1	336	460	1	1.21	413.7	111.2
RBT	1	331	365	1	1.01	395.3	92.3
RBT	1	326	370	1	1.07	377.5	98.0
RBT	1	313	390	1	1.27	333.8	116.8
RBT	1	313	315	1	1.03	333.8	94.4
RBT	1	311	355	1	1.18	327.4	108.4
RBT	1	310	310	1	1.04	324.2	95.6
RBT	1	290	276	1	1.13	265.0	104.1
RBT	1	283	295	1	1.3	246.2	119.8
RBT	1	282	218	1	0.97	243.5	89.5
RBT	1	280	286	1	1.3	238.3	120.0
RBT	1	235	132	1	1.02	140.3	94.1

Molycorp
Red River Upstream of Red River
09/15/99

BRK		LENGTH	WEIGHT	K	Ws	Wr
	N	23	23	23	19	19
	MIN	65	2.5	0.85	23.9	82.3
	MAX	238	156	1.29	140.3	125.7
	MEAN	157.4	53.4	1.0	61.4	99.4

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	6	6	6	4	4
	MIN	58	2.5	0.93	80.9	88.8
	MAX	305	290	1.28	304.4	100.1
	MEAN	203.7	128.1	1.1	198.8	94.6

CUTBOW		LENGTH	WEIGHT	K	Ws	Wr
	N	4	4	4		
	MIN	106	12	0.95		
	MAX	170	48	1.01		
	MEAN	133.8	25.8	1.0		

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	13	13	13	13	13
	MIN	235	132	0.97	140.3	89.5
	MAX	353	460	1.3	480.3	120.0
	MEAN	304.8	324.8	1.1	316.9	102.9

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRK	16	7	26	+/- 4.21	0.187	139	16.4
BRN	4	2	6	+/- 1.05	0.187	32	9.1
CUTBOW	2	2	4	+/- 0.00	0.187	21	1.2
RBT	13	0	13	+/- 0.00	0.187	70	49.8

Molycorp
Red River at Junebug Campground
09/16/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	254	164	1	1	177.1	92.6
BRN	1	217	102	1	1	111.1	91.8
BRN	1	215	100	1	1.01	108.1	92.5
BRN	1	214	90	1	0.92	106.6	84.4
BRN	1	211	88	1	0.94	102.2	86.1
BRN	1	182	52.0	1	0.86	66.0	78.8
BRN	2	217	100	1	0.98	111.1	90.0
BRN	2	214	88	1	0.9	106.6	82.6
BRN	2	213	98	1	1.01	105.1	93.2
BRN	2	207	98	1	1.1	96.6	101.5
BRN	2	201	68	1	0.84	88.5	76.8
BRN	2	198	74	1	0.95	84.7	87.4
BRN	2	175	52	1	0.97	58.7	88.5
BRN	2	140	31	1	1.13	30.3	102.2
BRN	3	161	40	1	0.96	45.9	87.2
BRN	3	106	11	1	0.92		
RBT	1	320	360	1	1.1	356.9	100.9
RBT	1	284	280	1	1.22	248.8	112.5
RBT	1	265	184	1	0.99	201.8	91.2
RBT	1	232	138	1	1.11	135.0	102.2
RBT	1	195	62	1	0.84		

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	16	16	16	15	15
	MIN	106	11	0.84	30.3	76.8
	MAX	254	164	1.13	177.1	102.2
	MEAN	195.3	78.5	1.0	93.2	89.1

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	5	5	5	4	4
	MIN	195	62	0.84	135.0	91.2
	MAX	320	360	1.22	356.9	112.5
	MEAN	259.2	204.8	1.1	235.6	101.7

	1st	2nd	3rd	Pop Est	CI	Site Area	Density	Biomass
BRN	6	8	2	16	+/- 0.00	0.139	115	19.9
RBT	5	0		5	+/- 0.00	0.139	36	16.2

Molycorp
Red River Downstream of Elephant Rock Campground
09/16/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRK	1	69	3.3	1	1.00		
BRK	1	67	2.8	1	0.93		
BRN	1	304	260	1	0.93	301.5	86.2
BRN	1	291	238	1	0.97	264.9	89.9
BRN	1	277	232	1	1.09	228.9	101.4
BRN	1	270	222	1	1.13	212.2	104.6
BRN	1	267	172	1	0.9	205.3	83.8
BRN	1	266	162	1	0.86	203.0	79.8
BRN	1	265	172	1	0.92	200.7	85.7
BRN	1	250	158	1	1.01	168.9	93.5
BRN	1	248	150	1	0.98	165.0	90.9
BRN	1	247	148	1	0.98	163.0	90.8
BRN	1	245	154	1	1.05	159.1	96.8
BRN	1	242	140	1	0.99	153.4	91.3
BRN	1	239	132	1	0.97	147.8	89.3
BRN	1	235	120	1	0.92	140.6	85.3
BRN	1	221	112	1	1.04	117.2	95.5
BRN	1	215	98	1	0.99	108.1	90.7
BRN	1	206	86	1	0.98	95.2	90.3
BRN	1	198	72	1	0.93	84.7	85.0
BRN	1	189	64	1	0.95	73.8	86.8
BRN	1	184	66	1	1.06	68.1	96.9
BRN	1	151	36	1	1.05	37.9	94.9
BRN	1	146	35	1	1.12	34.3	101.9
BRN	1	142	29	1	1.01	31.6	91.7
BRN	1	134	22	1	0.91		
BRN	1	122	16	1	0.88		
BRN	1	114	15	1	1.01		
BRN	1	112	14	1	1		
BRN	1	67	3.5	1	1.16		
BRN	2	314	230	1	0.74	331.8	69.3
BRN	2	272	194	1	0.96	216.9	89.5
BRN	2	255	174	1	1.05	179.1	97.1
BRN	2	226	134	1	1.16	125.3	107.0
BRN	2	223	110	1	0.99	120.4	91.4
BRN	2	213	96	1	0.99	105.1	91.3
BRN	2	212	112	1	1.18	103.7	108.0
BRN	2	209	94	1	1.03	99.4	94.6
BRN	2	161	44	1	1.05	45.9	95.9
BRN	2	158	37	1	0.94	43.4	85.3
BRN	2	142	30	1	1.05	31.6	94.9
RBT	1	274	218	1	1.06	223.2	97.7
RBT	1	269	224	1	1.15	211.1	106.1
RBT	1	254	168	1	1.03	177.5	94.6

Molycorp
Red River Downstream of Elephant Rock Campground
09/16/99

BRK		LENGTH	WEIGHT	K	Ws	Wr
	N	2	2	2		
	MIN	67	2.8	0.93		
	MAX	69	3.3	1		
	MEAN	68.0	3.1	0.97		

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	39	39	39	34	34
	MIN	67	3.5	0.74	31.6	69.3
	MAX	314	260	1.18	331.8	108.0
	MEAN	211.1	112.4	1.00	140.2	92.0

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	3	3	3	3	3
	MIN	254	168	1.03	177.5	94.6
	MAX	274	224	1.15	223.2	106.1
	MEAN	265.7	203.3	1.08	204.0	99.5

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRK	2	0	2	+/- 0.00	0.128	16	0.1
BRN	28	11	44	+/- 5.147	0.128	344	85.2
RBT	3	0	3	+/- 0.00	0.128	23	10.5

(7)

Molycorp
Red River Downstream of Hanson Creek
09/16/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	290	285	1	1.17	262.2	108.7
BRN	1	280	246	1	1.12	236.3	104.1
BRN	1	278	232	1	1.08	231.3	100.3
BRN	1	277	196	1	0.92	228.9	85.6
BRN	1	233	142	1	1.12	137.1	103.6
BRN	1	227	100	1	0.85	126.9	78.8
BRN	1	226	118	1	1.02	125.3	94.2
BRN	1	183	64	1	1.04	67.0	95.5
BRN	1	155	36	1	0.97	41.0	87.8
BRN	1	152	39	1	1.11	38.7	100.8
BRN	1	148	35	1	1.08	35.8	97.9
BRN	1	143	31	1	1.06	32.3	96.0
BRN	1	139	30	1	1.12		
BRN	1	120	17	1	0.98		
RBT	1	276	230	1	1.09	228.2	100.8

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	14	14	14	12	12
	MIN	120	17	0.85	32.3	78.8
	MAX	290	285	1.17	262.2	108.7
	MEAN	203.6	112.2	1.0	130.2	96.1

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	1	1	1	1	1
	MIN	276	230	1.09	228.2	100.8
	MAX	276	230	1.09	228.2	100.8
	MEAN	276	230	1.09	228.2	100.8

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	14	0	14	+/- 0.00	0.136	103	25.5
RBT	1	0	1	+/- 0.00	0.136	7	3.7

(8)

Molycorp
Red River Above Columbine Downstream of Mill
09/16/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	291	255	1	1.03	264.9	96.3
BRN	1	282	240	1	1.07	241.3	99.4
BRN	1	273	232	1	1.14	219.2	105.8
BRN	1	273	204	1	1	219.2	93.1
BRN	1	265	200	1	1.07	200.7	99.6
BRN	1	245	158	1	1.07	159.1	99.3
BRN	1	221	102	1	0.94	117.2	87.0
BRN	1	219	102	1	0.97	114.1	89.4
BRN	1	214	108	1	1.1	106.6	101.3
BRN	1	164	46	1	1.04	48.5	94.9
BRN	1	164	44	1	1	48.5	90.8
BRN	1	160	43	1	1.05	45.0	95.5
BRN	1	160	37	1	0.9	45.0	82.1
BRN	1	156	39	1	1.03	41.8	93.3
BRN	2	252	158	1	0.99	173.0	91.4
BRN	2	247	164	1	1.09	163.0	100.6
BRN	2	226	121	1	1.05	125.3	96.6
CUT	1	213	95	1	0.98		
CUT	1	210	94	1	1.02		
RBT	1	340	448	1	1.14	428.7	104.5
RBT	1	305	310	1	1.09	308.7	100.4

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	17	17	17	17	17
	MIN	156	37	0.9	41.8	82.1
	MAX	291	255	1.14	264.9	105.8
	MEAN	224.2	132.5	1.0	137.2	95.1

CUT		LENGTH	WEIGHT	K	Ws	Wr
	N	2	2	2		
	MIN	210	94	0.98		
	MAX	213	95	1.02		
	MEAN	211.5	94.5	1.0		

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	2	2	2	2	2
	MIN	305	310	1.09	308.7	100.4
	MAX	340	448	1.14	428.7	104.5
	MEAN	322.5	379.0	1.1	368.7	102.5

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	14	3	17	+/- 0.85	0.11	155	45.2
CUT	2	0	2	+/- 0.00	0.11	18	3.8
RBT	2	0	2	+/- 0.00	0.11	18	15.2

Molycorp
Red River at Goathill Campground
09/13/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	259	160	1	0.92	187.6	85.3
BRN	1	258	180	1	1.05	185.4	97.1
BRN	1	251	156	1	0.99	170.9	91.3
BRN	1	239	138	1	1.01	147.8	93.3
BRN	1	230	116	1	0.95	132.0	87.9
BRN	1	227	122	1	1.04	126.9	96.1
BRN	1	225	126	1	1.11	123.6	101.9
BRN	1	222	106	1	0.97	118.8	89.2
BRN	1	220	112	1	1.05	115.7	96.8
BRN	1	219	114	1	1.09	114.1	99.9
BRN	1	218	98	1	0.95	112.6	87.0
BRN	1	214	106	1	1.08	106.6	99.5
BRN	1	183	60	1	0.98	67.0	89.5
BRN	1	175	58	1	1.08	58.7	98.8
BRN	1	174	58	1	1.1	57.7	100.4
BRN	1	146	27	1	0.87	34.3	78.6
BRN	1	140	28	1	1.02	30.3	92.3
BRN	1	124	20	1	1.05		
BRN	1	121	21	1	1.19		
BRN	1	119	18	1	1.07		
BRN	1	101	11	1	1.07		
BRN	1	64	2.9	1	1.11		
BRN	1	55	1.9	1	1.14		
BRN	2	226	122	1	1.06	125.3	97.4
BRN	2	219	98	1	0.93	114.1	85.9
BRN	2	211	88	1	0.94	102.2	86.1
BRN	2	200	72	1	0.9	87.2	82.5
BRN	2	198	72	1	0.93	84.7	85.0
BRN	2	175	60	1	1.12	58.7	102.2
BRN	2	162	43	1	1.01	46.7	92.0
RBT	1	300	350	1	1.3	293.6	119.2
RBT	1	257	190	1	1.12	183.9	103.3
WHS	1	171	62	1	1.24		
WHS	1	126	25	1	1.25		
WHS	2	118	19	1	1.16		

Molycorp
Red River at Goathill Campground
09/13/99

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	30	30	30	24	24
	MIN	55	1.9	0.87	30.3	78.6
	MAX	259	180	1.19	187.6	102.2
	MEAN	185.8	79.8	1.03	104.6	92.3

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	2	2	2	2	2
	MIN	257	190	1.12	183.9	103.3
	MAX	300	350	1.3	293.6	119.2
	MEAN	278.5	270.0	1.2	238.8	111.2

WHS		LENGTH	WEIGHT	K	Ws	Wr
	N	3	3	3		
	MIN	118	19	1.16		
	MAX	171	62	1.25		
	MEAN	138.3	35.3	1.2		

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	23	7	31	+/- 2.11	0.202	153	27.0
RBT	2	0	2	+/- 0.00	0.202	10	5.9
WHS	2	1	3	+/- 0.75	0.202	15	1.2

Molycorp
Red River Upstream of Questa Ranger Station
09/13/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	281	226	1	1.02	238.8	94.6
BRN	1	239	138	1	1.01	147.8	93.3
BRN	1	197	80	1	1.05	83.4	95.9
BRN	1	189	70	1	1.04	73.8	94.9
BRN	1	187	66	1	1.01	71.5	92.3
BRN	1	187	58	1	0.89	71.5	81.1
BRN	1	154	35	1	0.96	40.2	87.0
BRN	1	115	14	1	0.92		
BRN	1	73	4.8	1	1.23		
BRN	2	227	134	1	1.15	126.9	105.6
BRN	2	154	37	1	1.01	40.2	92.0
BRN	2	129	20	1	0.93		
BRN	2	113	14	1	0.97		
RBT	1	289	234	1	0.97	262.3	89.2
WHS	1	132	24	1	1.04		
WHS	2	136	29	1	1.15		
WHS	2	71	3.4	1	0.95		

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	13	13	13	9	9
	MIN	73	4.8	0.89	40.22	81.14
	MAX	281	226	1.23	238.82	105.57
	MEAN	172.7	69.0	1.01	99.35	92.98

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	1	1	1	1	1
	MIN	289	234	0.97	262.3	89.3
	MAX	289	234	0.97	262.3	89.2
	MEAN	289	234	0.97	262.3	89.2

WHS		LENGTH	WEIGHT	K	Ws	Wr
	N	3	3	3		
	MIN	71	3.4	0.95		
	MAX	136	29	1.15		
	MEAN	113	18.8	1.05		

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	9	4	14	+/- 2.40	0.197	71	10.8
RBT	1	0	1	+/- 0.00	0.197	5	2.6
WHS	1	2	3	+/- 0.00	0.197	15	0.6

(12)

Molycorp
Red River Upstream of Hatchery Diversion
09/14/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	284	236	1	1.03	246.5	95.8
BRN	1	239	147	1	1.08	147.8	99.4
BRN	1	207	84	1	0.95	96.6	87.0
BRN	1	205	92	1	1.07	93.8	98.0
BRN	1	199	68	1	0.86	85.9	79.1
BRN	1	196	70	1	0.93	82.2	85.2
BRN	1	195	71	1	0.96	80.9	87.7
BRN	1	195	70	1	0.94	80.9	86.5
BRN	1	195	56	1	0.76	80.9	69.2
BRN	1	189	61	1	0.9	73.8	82.7
BRN	1	175	49	1	0.91	58.7	83.4
BRN	1	170	50	1	1.02	53.9	92.8
BRN	1	170	49	1	1	53.9	90.9
BRN	1	167	50	1	1.07	51.1	97.8
BRN	1	164	46	1	1.04	48.5	94.9
BRN	1	154	40	1	1.1	40.2	99.5
BRN	1	105	14	1	1.21		
BRN	1	99	10	1	1.03		
BRN	1	77	4.6	1	1.01		
BRN	1	76	4.4	1	1		
BRN	2	255	163	1	0.98	179.1	91.0
BRN	2	195	82	1	1.11	80.9	101.3
BRN	2	195	72	1	0.97	80.9	89.0
BRN	2	195	72	1	0.97	80.9	89.0
BRN	2	183	63	1	1.03	67.0	94.0
BRN	2	100	10	1	1		
BRN	2	84	7	1	1.18		
RBT	1	277	240	1	1.13	230.7	104.0
RBT	1	267	188	1	0.99	206.4	91.1
RBT	1	265	190	1	1.02	201.8	94.2
RBT	1	259	187	1	1.08	188.3	99.3
RBT	1	250	147	1	0.94	169.2	86.9
RBT	1	243	174	1	1.21	155.3	112.1
RBT	1	236	130	1	0.99	142.1	91.5
RBT	1	235	152	1	1.17	140.3	108.3
RBT	1	228	138	1	1.16	128.1	107.8
RBT	1	227	125	1	1.07	126.4	98.9
RBT	1	221	107	1	0.99	116.5	91.8
RBT	1	217	100	1	0.98	110.3	90.7
RBT	1	216	102	1	1.01	108.7	93.8
RBT	1	216	96	1	0.95	108.7	88.3
RBT	1	215	101	1	1.02	107.2	94.2
RBT	1	215	99	1	1	107.2	92.3
RBT	1	210	88	1	0.95	99.9	88.1
RBT	1	208	96	1	1.07	97.0	99.0
RBT	1	207	85	1	0.96	95.6	88.9
RBT	1	153	48	1	1.34		
RBT	2	264	204	1	1.11	199.5	102.3
RBT	2	226	124	1	1.07	124.7	99.4
RBT	2	218	103	1	0.99	111.8	92.1

(13)

Molycorp
Red River Upstream of Hatchery Diversion
09/14/99

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	27	27	27	21	21
	MIN	76	4.4	0.76	40.2	69.2
	MAX	284	236	1.21	246.5	101.3
	MEAN	172.9	64.5	1.0	88.8	90.2

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	23	23	23	22	22
	MIN	153	48	0.94	95.6	86.9
	MAX	277	240	1.34	230.7	112.1
	MEAN	229.3	131.5	1.1	139.8	96.1

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	20	7	29	+/- 2.96	0.157	185	26.3
RBT	20	3	23	+/- 0.70	0.157	146	42.5

Molycorp
Red River Downstream of Hatchery
09/14/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN	1	497	1250	1	1.02	1293.0	96.7
BRN	1	463	1050	1	1.06	1048.2	100.2
BRN	1	455	1350	1	1.43	995.5	135.6
BRN	1	412	620	1	0.89	741.9	83.6
BRN	1	313	310	1	1.01	328.7	94.3
BRN	1	305	290	1	1.02	304.4	95.3
BRN	1	301	278	1	1.02	292.8	95.0
BRN	1	292	264	1	1.06	267.6	98.7
BRN	1	286	248	1	1.06	251.6	98.6
BRN	1	261	195	1	1.1	191.9	101.6
BRN	1	261	188	1	1.06	191.9	98.0
BRN	1	249	162	1	1.05	166.9	97.0
BRN	1	246	152	1	1.02	161.0	94.4
BRN	1	245	164	1	1.12	159.1	103.1
BRN	1	236	136	1	1.03	142.4	95.5
BRN	1	235	132	1	1.02	140.6	93.9
BRN	1	234	125	1	0.98	138.9	90.0
BRN	1	232	148	1	1.19	135.4	109.3
BRN	1	225	132	1	1.16	123.6	106.8
BRN	1	225	112	1	0.98	123.6	90.6
BRN	1	224	112	1	1	122.0	91.8
BRN	1	221	110	1	1.02	117.2	93.8
BRN	1	220	114	1	1.07	115.7	98.5
BRN	1	216	108	1	1.07	109.6	98.6
BRN	1	207	82	1	0.92	96.6	84.9
BRN	1	204	84	1	0.99	92.5	90.8
BRN	1	200	86	1	1.08	87.2	98.6
BRN	1	198	80	1	1.03	84.7	94.5
BRN	1	151	40	1	1.16	37.9	105.4
BRN	1	114	15	1	1.01		
BRN	1	112	15	1	1.07		
BRN	1	110	14	1	1.05		
BRN	1	109	13	1	1		
BRN	1	106	12	1	1.01		
BRN	1	105	12	1	1.04		
BRN	1	103	11	1	1.01		
BRN	1	97	9	1	0.99		
BRN	1	96	9.8	1	1.11		
BRN	1	92	8.6	1	1.1		
BRN	1	90	7.9	1	1.08		
BRN	1	90	7.7	1	1.06		
BRN	1	87	7	1	1.06		
BRN	1	84	6.1	1	1.03		
BRN	1	80	5.3	1	1.04		

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Red River Downstream of Hatchery
09/14/99

BRN	1	79	5.3	1	1.07		
BRN	1	77	5.3	1	1.16		
BRN	2	334	410	1	1.1	398.4	102.9
BRN	2	295	246	1	0.96	275.8	89.2
BRN	2	251	158	1	1	170.9	92.4
BRN	2	244	140	1	0.96	157.2	89.1
BRN	2	224	104	1	0.93	122.0	85.2
BRN	2	223	108	1	0.97	120.4	89.7
BRN	2	196	74	1	0.98	82.2	90.1
BRN	2	195	74	1	1	80.9	91.4
BRN	2	131	24	1	1.07		
BRN	2	108	12	1	0.95		
BRN	2	94	8.7	1	1.05		
BRN	2	86	7.7	1	1.21		
BRN	2	86	7.1	1	1.12		
BRN	2	79	4.5	1	0.91		
RBT	1	279	216	1	0.99	235.8	91.6
RBT	1	268	174	1	0.9	208.8	83.3
RBT	1	248	150	1	0.98	165.1	90.8
RBT	1	242	152	1	1.07	153.3	99.1
RBT	1	214	102	1	1.04	105.7	96.5
RBT	1	155	40	1	1.07		
RBT	2	280	214	1	0.97	238.3	89.8
RBT	2	175	62	1	1.16		
RBT	2	162	46	1	1.08		
RBT	2	123	19	1	1.02		

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	60	60	60	37	37
	MIN	77	4.5	0.89	37.9	83.6
	MAX	497	1350	1.43	1293.0	135.6
	MEAN	199.9	161.1	1.0	256.0	96.3

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	10	10	10	6	6
	MIN	123	19	0.9	105.7	83.3
	MAX	280	216	1.16	238.3	99.1
	MEAN	214.6	117.5	1.0	184.5	91.9

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN	46	14	64	+/- 3.86	0.212	302	107.2
RBT	6	4	10	+/- 0.00	0.212	47	12.2

16

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Columbine Creek
09/15/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRN < 100	1	98	10	1	1.06		
BRN < 100	1	96	9	1	1.02		
BRN < 100	1	95	11	1	1.28		
BRN < 100	1	53	1.4	1	0.94		
BRN < 100	1	50	1.3	1	1.04		
BRN < 100	1	50	1.3	1	1.04		
BRN < 100	1	50	1.1	1	0.88		
BRN < 100	2	50	1.4	1	1.12		
BRN < 100	2	50	1.2	1	0.96		
BRN < 100	2	48	1.4	1	1.27		
BRN < 100	2	46	1.3	1	1.34		
BRN < 100	2	45	1	1	1.1		
BRN < 100	2	40	0.5	1	0.78		
BRN > 100	1	277	200	1	0.94	228.9	87.4
BRN > 100	1	255	158	1	0.95	179.1	88.2
BRN > 100	1	249	166	1	1.08	166.9	99.4
BRN > 100	1	222	110	1	1.01	118.8	92.6
BRN > 100	1	203	72	1	0.86	91.2	79.0
BRN > 100	1	200	72	1	0.9	87.2	82.5
BRN > 100	1	198	74	1	0.95	84.7	87.4
BRN > 100	1	197	76	1	0.99	83.4	91.1
BRN > 100	1	195	68	1	0.92	80.9	84.0
BRN > 100	1	190	62	1	0.9	74.9	82.7
BRN > 100	1	190	58	1	0.85	74.9	77.4
BRN > 100	1	183	54	1	0.88	67.0	80.5
BRN > 100	1	149	33	1	1	36.5	90.5
BRN > 100	1	148	30	1	0.93	35.8	83.9
BRN > 100	1	112	13	1	0.93		
BRN > 100	2	226	124	1	1.07	125.3	99.0
BRN > 100	2	207	82	1	0.92	96.6	84.9
BRN > 100	2	201	80	1	0.99	88.5	90.4
BRN > 100	2	177	50	1	0.9	60.7	82.3
BRN > 100	2	149	31	1	0.94	36.5	85.0
BRN > 100	2	145	32	1	1.05	33.6	95.1
BRN > 100	2	102	11	1	1.04		
CUT	1	207	82	1	0.92		

(17)

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Columbine Creek
09/15/99

BRN < 100		LENGTH	WEIGHT	K	Ws	Wr
	N	13	13	13		
	MIN	40	0.5	0.78		
	MAX	98	11	1.34		
	MEAN	59.3	3.2	1.1		

BRN > 100		LENGTH	WEIGHT	K	Ws	Wr
	N	22	22	22	20	20
	MIN	102	11	0.85	33.6	77.4
	MAX	277	200	1.08	228.9	99.4
	MEAN	189.8	75.3	1.0	92.6	87.2

CUT		LENGTH	WEIGHT	K	Ws	Wr
	N	1	1	1		
	MIN	207	82	0.92		
	MAX	207	82	0.92		
	MEAN	207	82	0.92		

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRN < 100	7	6	13	+/- 0.00	0.076	171	1.2
BRN > 100	15	7	25	+/- 4.36	0.076	329	54.6
CUT	1	0	1	+/- 0.00	0.076	13	2.4

18

Molycorp
Cabresto Creek
09/17/99

SPECIES	PASS	LENGTH	WEIGHT	COUNT	K	Ws	Wr
BRK	1	195	74	1	1	76.5	96.8
BRK	1	167	48	1	1.03	47.7	100.6
BRK	1	124	15	1	0.79		
BRK	1	80	5	1	0.98		
BRK	1	79	4.5	1	0.91		
BRK	1	78	4.8	1	1.01		
BRK	1	77	4.6	1	1.01		
BRK	1	64	2.5	1	0.95		
BRK	1	63	2.4	1	0.96		
BRN	1	197	72	1	0.94	83.4	86.3
BRN	1	153	37	1	1.03	39.5	93.8
CUTBOW	1	214	105	1	1.07		
CUTBOW	1	211	96	1	1.02		
CUTBOW	1	200	76	1	0.95		
CUTBOW	1	198	68	1	0.88		
CUTBOW	1	196	69	1	0.92		
CUTBOW	1	189	68	1	1.01		
CUTBOW	1	188	67	1	1.01		
CUTBOW	1	187	66	1	1.01		
CUTBOW	1	186	68	1	1.06		
CUTBOW	1	184	55	1	0.88		
CUTBOW	1	181	60	1	1.01		
CUTBOW	1	180	58	1	0.99		
CUTBOW	1	180	56	1	0.96		
CUTBOW	1	175	59	1	1.1		
CUTBOW	1	175	54	1	1.01		
CUTBOW	1	173	57	1	1.1		
CUTBOW	1	170	45	1	0.92		
CUTBOW	1	168	31	1	0.65		
CUTBOW	1	164	46	1	1.04		
CUTBOW	1	161	36	1	0.86		
CUTBOW	1	160	40	1	0.98		
CUTBOW	1	157	39	1	1.01		
CUTBOW	1	155	23	1	0.62		
CUTBOW	1	148	35	1	1.08		
CUTBOW	1	137	38	1	1.48		
CUTBOW	1	136	24	1	0.95		
CUTBOW	1	136	22	1	0.87		
CUTBOW	1	134	23	1	0.96		
CUTBOW	1	129	19	1	0.89		
CUTBOW	1	127	21	1	1.03		
CUTBOW	1	127	21	1	1.03		
CUTBOW	1	125	20	1	1.02		
CUTBOW	1	125	19	1	0.97		
CUTBOW	1	123	18	1	0.97		
CUTBOW	1	120	18	1	1.04		

Molycorp
Cabresto Creek
09/17/99

CUTBOW	1	114	14	1	0.94		
CUTBOW	1	113	15	1	1.04		
CUTBOW	1	112	15	1	1.07		
CUTBOW	1	112	13	1	0.93		
CUTBOW	1	111	14	1	1.02		
CUTBOW	1	108	13	1	1.03		
CUTBOW	1	102	11	1	1.04		
CUTBOW	1	98	9.6	1	1.02		
CUTBOW	1	95	9	1	1.05		
CUTBOW	1	47	0.8	1	0.77		
CUTBOW	1	43	0.6	1	0.75		
CUTBOW	1	42	0.7	1	0.94		
CUTBOW	2	211	82	1	0.87		
CUTBOW	2	203	78	1	0.93		
CUTBOW	2	190	70	1	1.02		
CUTBOW	2	188	62	1	0.93		
CUTBOW	2	183	57	1	0.93		
CUTBOW	2	175	54	1	1.01		
CUTBOW	2	170	45	1	0.92		
CUTBOW	2	169	42	1	0.87		
CUTBOW	2	152	39	1	1.11		
CUTBOW	2	151	33	1	0.96		
CUTBOW	2	150	36	1	1.07		
CUTBOW	2	144	31	1	1.04		
CUTBOW	2	143	27	1	0.92		
CUTBOW	2	135	23	1	0.93		
CUTBOW	2	130	25	1	1.14		
CUTBOW	2	125	19	1	0.97		
CUTBOW	2	116	14	1	0.9		
CUTBOW	2	109	12	1	0.93		
CUTBOW	2	105	9.5	1	0.82		
CUTBOW	2	100	10	1	1		
CUTBOW	2	46	0.7	1	0.72		
CUTBOW	2	45	0.7	1	0.77		
CUTBOW	2	43	1	1	1.26		
RBT	1	300	302	1	1.12	293.6	102.8
RBT	1	296	260	1	1	282.0	92.2
RBT	1	266	172	1	0.91	204.1	84.3
RBT	1	255	172	1	1.04	179.6	95.8
RBT	1	255	162	1	0.98	179.6	90.2
RBT	1	248	158	1	1.04	165.1	95.7
RBT	1	245	140	1	0.95	159.2	88.0
RBT	1	235	122	1	0.94	140.3	86.9
RBT	1	214	100	1	1.02	105.7	94.6
RBT	2	259	194	1	1.12	188.3	103.0
RBT	2	242	140	1	0.99	153.3	91.3

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Cabresto Creek
09/17/99

BRK		LENGTH	WEIGHT	K	Ws	Wr
	N	9	9	9	2	2
	MIN	63	2.4	0.79	47.7	96.8
	MAX	195	74	1.03	76.5	100.6
	MEAN	103.0	17.9	0.96	62.1	98.7

BRN		LENGTH	WEIGHT	K	Ws	Wr
	N	2	2	2	2	2
	MIN	153	37	0.94	39.5	86.3
	MAX	197	72	1.03	83.4	93.8
	MEAN	175.0	54.5	0.99	61.4	90.1

CUTBOW		LENGTH	WEIGHT	K	Ws	Wr
	N	70	70	70		
	MIN	42	0.6	0.62		
	MAX	214	105	1.48		
	MEAN	142.8	35.8	0.97		

RBT		LENGTH	WEIGHT	K	Ws	Wr
	N	11	11	11	11	11
	MIN	214	100	0.91	105.7	84.3
	MAX	300	302	1.12	293.6	103.0
	MEAN	255.9	174.7	1.01	186.4	93.2

	1st	2nd	Pop Est	CI	Site Area	Density	Biomass
BRK	9	0	9	+/- 0.00	0.085	106	4.2
BRN	2	0	2	+/- 0.00	0.085	24	2.8
CUTBOW	47	23	88	+/- 12.96	0.085	1035	81.7
RBT	9	2	11	+/- 0.70	0.085	129	49.9

APPENDIX C

Benthic Invertebrate Data

(1)

MACROINVERTEBRATE DENSITY
SITE: MIDDLE FORK OF RED RIVER
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1340	980	1440	3360	1820	1788
Cultus sp.	30				40	14
Isoperla sp.	30					6
Megarcys signata		20	60	40	20	28
Perlomyia sp.	200	120	40		20	76
Sweltsa sp.	330	360	500	1200	740	626
Taenionema sp.	600	200	540	1440	640	684
Zapada cinctipes	150	280	300	680	360	354
EPHEMEROPTERA	1150	700	1080	3600	1460	1598
Baetis bicaudatus		10				2
Baetis tricaudatus	410	210	180	1240	360	480
Cinygmula sp.	10	90	40	280	120	108
Drunella coloradensis				120	20	28
Drunella doddsi	280	160	260	600	440	348
Epeorus deceptivus	110	40	100	200	60	102
Heptagenia sp.		30	20	80	20	30
Rhithrogena hageni	330	160	480	1080	440	498
Serratella micheneri	10					2
TRICHOPTERA	450	500	820	1000	720	698
Glossosoma sp.	40	10	20	120	40	46
Rhyacophila brunnea gr.	80	90	120	280	100	134
Rhyacophila sibirica gr.	330	400	680	600	580	518
COLEOPTERA	70	130	60	40		60
Optioservus sp.	70	130	60	40		60
DIPTERA	410	600	300	840	860	602
Chelifera/Metachela		30		40		14
Cricotopus sp.	20					4
Diamesa sp.		10		40		10
Hemerodromia sp.		40			40	16
Heterotrissocladius sp.	120	360	300	640	430	370
Mallochohelea sp.		80		40	40	32
Pagastia sp.	140	10		40	250	88
Pericoma sp.	10	10		40	40	20
Rheotanytarsus sp.	120	50				34
Simulium sp.		10			60	14
TURBELLARIA	90		20	80	100	58
Dugesia sp.	90		20	80	100	58

②

MACROINVERTEBRATE DENSITY
SITE: MIDDLE FORK OF RED RIVER
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA			60			12
Unid. Nematoda			60			12
HYDRACARINA	40		180		200	84
Lebertia sp.	40		180		200	84
TOTAL (#/sq. meter)	3550	2910	3960	8920	5160	4900
NUMBER OF TAXA	23	25	19	22	24	33
SHANNON-WEAVER (H')	3.88	3.93	3.61	3.63	3.86	3.92
TOTAL EPT TAXA	15	15	14	14	16	19
EPT INDEX (% of Total Taxa)	65	60	74	64	67	58
EPHEMEROPTERA ABUNDANCE (% of Total Density)	32	24	27	40	28	33

3

MACROINVERTEBRATE DENSITY
SITE: RED RIVER UPSTREAM OF RED RIVER
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	420	840	260	150	300	394
Despaxia augusta	20	40		10	40	22
Podmosta/Prostoia	20			10	40	14
Sweltsa sp.	280	720	240	80	200	304
Taenionema sp.	100	80	20	50	20	54
EPHEMEROPTERA	2080	3720	1660	960	1320	1948
Baetis tricaudatus	180	200	80	150	340	190
Cinygmula sp.		80	20	10		22
Drunella coloradensis	20	80	120			44
Drunella doddsi	1440	2520	1340	560	700	1312
Drunella grandis	20	40		30	60	30
Epeorus deceptivus	20	40				12
Ephemerella infrequens		80			20	20
Rhithrogena hageni	400	680	100	210	200	318
TRICHOPTERA	540	920	660	890	400	682
Arctopsyche grandis	40	40		10		18
Brachycentrus americanus	200	320	280	170	120	218
Hydropsyche sp.					20	4
Lepidostoma sp.	20					4
Rhyacophila sibirica gr.	280	560	380	710	260	438
COLEOPTERA	280	200	180	40	80	156
Heterlimnius corpulentus	260	200	180	40	80	152
Zaitzevia parvula	20					4
DIPTERA	3500	6680	2180	1770	4200	3666
Chelifera/Metachela					20	4
Cricotopus sp.	980	1330	550	130	2220	1042
Diamesa sp.		400	90	40		106
Dicranota sp.	20	120		10		30
Heterotrissocladius sp.	920	2100	180	730	520	890
Mallochohelea sp.	140	280	100	70	140	146
Pagastia sp.			60	130	80	54
Pericoma sp.	1240	2200	1000	370	1180	1198
Rhabdomastix sp.			20		40	12
Rheotanytarsus sp.		130				26
Simulium sp.	180	80	180	290		146
Tipula sp.	20	40				12
TURBELLARIA	140	40		10		38
Polycelis coronata	140	40		10		38
ANNELIDA						
OLIGOCHAETA	180	280	100	130	220	182
Eiseniella tetraedra		40			20	12
Homochaeta naidina	180	240	100	130	200	170

(4)

MACROINVERTEBRATE DENSITY
SITE: RED RIVER UPSTREAM OF RED RIVER
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA			60	20		16
Unid. Nematoda			60	20		16
HYDRACARINA	760	360	120	70	400	342
Lebertia sp.	760	360	120	70	400	342
TOTAL (#/sq. meter)	7900	13040	5220	4040	6920	7424
NUMBER OF TAXA	26	28	21	25	23	36
SHANNON-WEAVER (H')	3.68	3.67	3.52	3.68	3.32	3.78
TOTAL EPT TAXA	14	14	9	12	12	17
EPT INDEX (% of Total Taxa)	54	50	43	48	52	47
EPHEMEROPTERA ABUNDANCE (% of Total Density)	26	29	32	24	19	26

MACROINVERTEBRATE DENSITY
SITE: RED RIVER AT JUNEBUG CAMPGROUND
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA		20		10	30	12
Sweltsa sp.		20		10	30	12
EPHEMEROPTERA	3580	2260	3100	1780	560	2256
Baetis tricaudatus	80	120	80	80	50	82
Cinygmula sp.	20			50	20	18
Drunella coloradensis	120	40	20	90	30	60
Drunella doddsi	260	140	200	200	70	174
Drunella grandis	3080	1960	2760	1360	390	1910
Rhithrogena robusta	20		40			12
TRICHOPTERA	660	220	360	250	220	342
Arctopsyche grandis	60	40		10		22
Brachycentrus americanus	600	160	320	190	180	290
Rhyacophila sibirica gr.		20	40	50	40	30
COLEOPTERA	40	100	100	80	20	68
Heterlimnius corpulentus	40	100	100	80	20	68
DIPTERA	520	700	800	400	180	520
Atherix pachypus	60	20	20	10	10	24
Chelifera/Metachela		40	40	70	10	32
Cricotopus sp.	60	80	130	30		60
Diamesa sp.		20				4
Dicranota sp.			20			4
Hemerodromia sp.		40				8
Heterotrissocladius sp.	240	300	330	160	80	222
Hexatoma sp.			40		20	12
Mallochohelea sp.			20	40	10	14
Pagastia sp.	140	80	40	10		54
Pericoma sp.			40	10	20	14
Rhabdomastix sp.		40	40	30		22
Rheotanytarsus sp.		40	40	10		18
Simulium sp.	20	40	40	30	30	32
TURBELLARIA		40				8
Polycelis coronata		40				8
HYDRACARINA	1020	1880	920	690	360	974
Lebertia sp.	1020	1860	920	690	360	970
Sperchon sp.		20				4
TOTAL (#/sq. meter)	5820	5220	5280	3210	1370	4180
NUMBER OF TAXA	15	22	21	21	17	28
SHANNON-WEAVER (H')	2.32	2.60	2.54	2.85	3.06	2.68
TOTAL EPT TAXA	8	8	7	9	8	10
EPT INDEX (% of Total Taxa)	53	36	33	43	47	36
EPHEMEROPTERA ABUNDANCE (% of Total Density)	62	43	59	55	41	54

6

MACROINVERTEBRATE DENSITY
SITE: RED RIVER UPSTREAM OF HANSEN CREEK AT ELEPHANT ROCK CAMPGROUND
SAMPLED: 9/16/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	40	40	80	10	0	34
Sweltsa sp.	40	40	60	10		30
Zapada cinctipes			20			4
EPHEMEROPTERA	2620	4040	2300	920	2220	2420
Baetis tricaudatus	240	440	220	60	60	204
Drunella doddsi	60	120	20	30	40	54
Drunella grandis	700	1200	1040	680	1020	928
Epeorus albertae			20	10	20	10
Rhithrogena hageni	1620	2280	1000	140	1080	1224
TRICHOPTERA	140	760	800	140	240	416
Arctopsyche grandis	60	120	80	20		56
Brachycentrus americanus	60	600	720	120	240	348
Rhyacophila rotunda gr.	20	40				12
COLEOPTERA		40	60	60		32
Heterlimnius corpulentus		40	60	60		32
DIPTERA	2940	6240	3780	1630	2900	3498
Atherix pachypus	60	80	80	70	40	66
Chelifera/Metachela			80	20	20	24
Cricotopus sp.	840	650	800	600	1650	908
Diamesa sp.					90	18
Dicranota sp.	20		20	20	20	16
Heterotrissocladius sp.	1280	2030	2020	670	890	1378
Hexatoma sp.			20			4
Lispoides sp.				10		2
Pagastia sp.			220	50	90	72
Pericoma sp.				10		2
Rhabdomastix sp.	20					4
Simulium sp.	720	3480	540	180	100	1004
ANNELIDA						
OLIGOCHAETA			280		40	64
Homochaeta naidina			280		40	64
CRUSTACEA						
AMPHIPODA				20		4
Hyalella azteca				20		4
HYDRACARINA	80	40	340	10	340	162
Lebertia sp.	80	40	340	10	340	162
TOTAL (#/sq. meter)	5820	11160	7640	2790	5740	6630
NUMBER OF TAXA	15	14	20	20	16	26
SHANNON-WEAVER (H')	2.82	2.74	3.31	3.03	2.86	3.15
TOTAL EPT TAXA	8	8	9	8	6	10
EPT INDEX (% of Total Taxa)	53	57	45	40	38	38
EPHEMEROPTERA ABUNDANCE (% of Total Density)	45	36	30	33	39	37

7

MACROINVERTEBRATE DENSITY
SITE: RED RIVER DOWNSTREAM OF HANSEN CREEK
SAMPLED: 9/16/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	20	10	10	20	0	12
Cultus sp.				10		2
Megarcys sp.	20	10	10			8
Zapada cinctipes				10		2
EPHEMEROPTERA	2760	1840	1780	1360	2200	1988
Baetis tricaudatus	220	190	190	100	370	214
Drunella doddsi	60	10	30	10	20	26
Drunella grandis	1840	1510	1520	1250	1740	1572
Epeorus albertae			10			2
Rhithrogena hageni	640	120	30		70	172
Serratella tibialis		10				2
TRICHOPTERA	2600	320	860	1050	440	1054
Arctopsyche grandis	100	30	50	40	20	48
Brachycentrus americanus	2480	220	790	980	400	974
Hydropsyche sp.				10		2
Lepidostoma sp.		10				2
Limnephilus/Philarctus					10	2
Rhyacophila rotunda gr.	20	50	20	20	10	24
Rhyacophila sibirica gr.		10				2
COLEOPTERA	140	0	20	20	30	42
Heterlimnius corpulentus	120		20	20	30	38
Narpus concolor	20					4
DIPTERA	600	280	270	460	360	394
Atherix pachypus			20	10	20	10
Chelifera/Metachela	20		20	20	20	16
Diamesa sp.			10			2
Dicranota sp.			50	10	10	14
Heterotrissocladius sp.	480	190	100	280	220	254
Monohelea sp.			10			2
Pagastia sp.	20	50	50	120	50	58
Protanyderus sp.			10			2
Rhabdomastix sp.	20	20		20	10	14
Rheotanytarsus sp.	60	10			10	16
Simulium sp.		10			10	4
Tipula sp.					10	2
ANNELIDA						
OLIGOCHAETA				70		14
Homochaeta naidina				70		14
NEMATODA		10	10	10	10	8
Unid. Nematoda		10	10	10	10	8

MACROINVERTEBRATE DENSITY
SITE: RED RIVER DOWNSTREAM OF HANSEN CREEK
SAMPLED: 9/16/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA	680	10	200	420	240	310
Lebertia sp.	660	10	200	420	240	306
Testudacarus/Torrenticola	20					4
MOLLUSCA						
GASTROPODA			10			2
Gyraulus sp.			10			2
TOTAL (#/sq. meter)	6800	2470	3160	3410	3280	3824
NUMBER OF TAXA	17	18	21	19	20	35
SHANNON-WEAVER (H')	2.60	2.18	2.44	2.57	2.40	2.65
TOTAL EPT TAXA	8	11	9	9	8	16
EPT INDEX (% of Total Taxa)	47	61	43	47	40	46
EPHEMEROPTERA ABUNDANCE (% of Total Density)	41	74	56	40	67	52

MACROINVERTEBRATE DENSITY
SITE: RED RIVER DOWNSTREAM OF MILL PROPERTY LINE, UPSTREAM OF COLUMBINE
SAMPLED: 9/16/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	0	0	10	40	10	12
Cultus sp.			10	20	10	8
Perlomyia sp.				20		4
EPHEMEROPTERA	1120	640	1340	1510	980	1118
Baetis tricaudatus	640	290	550	590	440	502
Cinygmula sp.	20	10	20	10		12
Drunella doddsi			30	20		10
Drunella grandis	380	290	490	420	530	422
Rhithrogena hageni	80	50	250	470	10	172
TRICHOPTERA	420	220	550	550	530	454
Arctopsyche grandis	20	20	70	20	10	28
Brachycentrus americanus	340	180	290	350	470	326
Hydropsyche sp.			20			4
Lepidostoma sp.				10		2
Rhyacophila rotunda gr.	40	10	170	160	50	86
Rhyacophila sibirica gr.	20	10		10		8
LEPIDOPTERA				10		2
Cosmopterigidae				10		2
COLEOPTERA	0	10	10	40	20	16
Heterlimnius corpulentus		10	10	40		12
Optioservus divergens					20	4
DIPTERA	660	600	1140	1090	1650	1028
Atherix pachypus	20	10		20	20	14
Chelifera/Metachela	40	10	10	30	200	58
Cricotopus sp.	140	130		370	450	218
Culicoides sp.				30		6
Dicranota sp.			20		20	8
Empididae					20	4
Heterotrissocladius sp.	340	380	900	510	880	602
Pagastia sp.			30	40	50	24
Pericoma sp.		10		10	10	6
Rhabdomastix sp.	20	20		40		16
Rheotanytarsus sp.	20					4
Simulium sp.	80	40	180	40		68

MACROINVERTEBRATE DENSITY
SITE: RED RIVER DOWNSTREAM OF MILL PROPERTY LINE, UPSTREAM OF COLUMBINE
SAMPLED: 9/16/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA			60	30		18
Homochaeta naidina			60	30		18
HYDRACARINA	120	60	40	200	40	92
Lebertia sp.	120	60	40	200	40	92
TOTAL (#/sq. meter)	2320	1530	3150	3470	3230	2740
NUMBER OF TAXA	16	17	18	25	17	30
SHANNON-WEAVER (H')	3.11	3.05	3.10	3.53	2.93	3.36
TOTAL EPT TAXA	8	8	10	12	7	13
EPT INDEX (% of Total Taxa)	50	47	56	48	41	43
EPHEMEROPTERA ABUNDANCE (% of Total Density)	48	42	43	44	30	41

MACROINVERTEBRATE DENSITY
SITE: RED RIVER AT GOAT HILL CAMPGROUND
SAMPLED: 9/13/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA		20	20		20	12
Pteronarcella badia		10	10			4
Sweltsa sp.			10			2
Taenionema sp.		10			20	6
EPHEMEROPTERA	2770	700	1600	2720	1260	1810
Baetis bicaudatus		110	280			78
Baetis tricaudatus	2460	110	250	760	220	760
Drunella coloradensis	150	160	250	140	120	164
Drunella doddsi		40			20	12
Rhithrogena hageni	160	280	820	1820	900	796
TRICHOPTERA	30	70	210	140	40	98
Arctopsyche grandis		30	30		30	18
Brachycentrus americanus	10	20	160	140	10	68
Cheumatopsyche sp.	20	20	10			10
Rhyacophila sibirica gr.			10			2
COLEOPTERA	10		10			4
Heterlimnius corpulentus	10					2
Narpus concolor			10			2
DIPTERA	200	300	1040	1680	380	720
Atherix pachypus	40		40	20	10	22
Chelifera/Metachela	20	30	30		10	18
Cricotopus sp.	10	10		60	10	18
Dicranota sp.				20		4
Hemerodromia sp.					10	2
Heterotrissocladius sp.	110	210	750	1310	310	538
Pagastia sp.	20	20	140	190		74
Protanyderus margarita		10				2
Rhabdomastix sp.			10	20		6
Rheotanytarsus sp.				60		12
Simulium sp.		20	70		30	24
NEMATODA		30				6
Unid. Nematoda		30				6
HYDRACARINA	100			260	50	82
Lebertia sp.	100			260	50	82
TOTAL (#/sq. meter)	3110	1120	2880	4800	1750	2732
NUMBER OF TAXA	12	17	17	12	14	27
SHANNON-WEAVER (H')	1.33	3.26	2.93	2.43	2.28	2.78
TOTAL EPT TAXA	5	10	10	4	7	12
EPT INDEX (% of Total Taxa)	42	59	59	33	50	44
EPHEMEROPTERA ABUNDANCE (% of Total Density)	89	63	56	57	72	66

MACROINVERTEBRATE DENSITY
SITE: RED RIVER UPSTREAM OF QUESTA RANGER STATION
SAMPLED: 9/13/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	10		20			6
Despaxia augusta	10					2
Pteronarcella badia			10			2
Sweltsa sp.			10			2
EPHEMEROPTERA	790	960	480	810	890	786
Baetis tricaudatus	190	340	150	200	340	244
Drunella coloradensis	10	20	10			8
Drunella grandis	20					4
Rhithrogena hageni	570	600	320	610	550	530
TRICHOPTERA	90	400	90	20	140	148
Arctopsyche grandis	30	180	20	10	10	50
Brachycentrus americanus	50	180	60	10	100	80
Hydropsyche sp.	10	30			10	10
Lepidostoma sp.		10			10	4
Rhyacophila rotunda gr.			10			2
Rhyacophila sibirica gr.					10	2
COLEOPTERA	70	10	10		40	26
Narpus concolor	70		10		40	24
Optioservus divergens		10				2
DIPTERA	380	370	160	110	330	270
Atherix pachypus	20				10	6
Dicranota sp.		10		20		6
Heterotrissocladius sp.	330	330	160	90	300	242
Protanyderus sp.		10			10	4
Rhabdomastix sp.					10	2
Simulium sp.	30	20				10
HYDRACARINA		10		10		4
Lebertia sp.		10		10		4
TOTAL (#/sq. meter)	1340	1750	760	950	1400	1240
NUMBER OF TAXA	12	13	10	7	12	22
SHANNON-WEAVER (H')	2.41	2.58	2.30	1.53	2.28	2.42
TOTAL EPT TAXA	8	7	8	4	7	13
EPT INDEX (% of Total Taxa)	67	54	80	57	58	59
EPHEMEROPTERA ABUNDANCE (% of Total Density)	59	55	63	85	64	63

MACROINVERTEBRATE DENSITY
SITE: RED RIVER UPSTREAM OF HATCHERY DIVERSION
SAMPLED: 9/14/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	100	20	20	10		30
Cultus sp.			20			4
Isogenoides sp.	20					4
Pteronarcella badia	60	20		10		18
Zapada cinctipes	20					4
EPHEMEROPTERA	2200	3300	1820	2420	1800	2308
Baetis tricaudatus	1840	2900	1500	2170	1450	1972
Drunella grandis	60	40	100	10	10	44
Epeorus albertae				10	10	4
Rhithrogena hageni	300	360	220	230	330	288
TRICHOPTERA	3380	2580	1020	2930	290	2040
Arctopsyche grandis				30		6
Brachycentrus americanus	400	20	220	290	10	188
Culoptila sp.				10		2
Hydropsyche sp.	2980	2520	760	2590	280	1826
Lepidostoma sp.			40	10		10
Rhyacophila brunnea gr.		40				8
COLEOPTERA	340	380	620	280	170	358
Narpus concolor		20	20		20	12
Optioservus quadrimaculatus	260	320	600	270	150	320
Zaitzevia parvula	80	40		10		26
DIPTERA	840	680	1320	790	250	776
Atherix pachypus	580	220	460	360	130	350
Chelifera/Metachela			20			4
Cricotopus sp.		20	60	40		24
Heterotrissocladius sp.	100	240	660	290	80	274
Hexatoma sp.	20	40	100		10	34
Mallochohelea sp.	20	120		30		34
Pagastia sp.					30	6
Rheotanytarsus sp.	20					4
Simulium sp.	100	40	20	70		46
HYDRACARINA		40				8
Atractides sp.		40				8
Lebertia sp.		20	20	10		10
MOLLUSCA						
GASTROPODA			20		10	6
Fossaria sp.			20		10	6
TOTAL (#/sq. meter)	6860	7020	4840	6440	2520	5536
NUMBER OF TAXA	16	18	17	18	13	29
SHANNON-WEAVER (H')	2.44	2.28	3.00	2.35	2.11	2.60
TOTAL EPT TAXA	8	7	7	10	6	14
EPT INDEX (% of Total Taxa)	50	39	41	56	46	48
EPHEMEROPTERA ABUNDANCE (% of Total Density)	32	47	38	38	71	42

MACROINVERTEBRATE DENSITY
SITE: RED RIVER DOWNSTREAM OF HATCHERY
SAMPLED: 9/14/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	20	20		10		10
Isoperla sobria		20		10		6
Pteronarcella badia	10					2
Zapada cinctipes	10					2
EPPHEMEROPTERA	620	1960	1000	1350	1450	1276
Baetis tricaudatus	560	1860	900	1270	1260	1170
Drunella doddsi	10					2
Drunella grandis	10		10		10	6
Rhithrogena hageni	10	40	80		50	36
Rhithrogena robusta	30	60	10	80	130	62
TRICHOPTERA	710	1720	490	850	2010	1156
Brachycentrus americanus	70	140	10	30	110	72
Brachycentrus occidentalis	110		50	90	30	56
Cheumatopsyche sp.	490	1520	380	720	1830	988
Hydropsyche sp.	40	60	40		30	34
Rhyacophila sibirica gr.			10	10	10	6
COLEOPTERA	40		30	60	130	52
Heterlimnius corpulentus	40		20	50	120	46
Narpus concolor				10	10	4
Zaitzevia parvula			10			2
DIPTERA	310	350	180	270	450	312
Atherix pachypus	10		10	10	20	10
Caloparyphus sp.	20			10		6
Cricotopus sp.			10		50	12
Dicranota sp.			20		20	8
Heterotrissocladius sp.	190	110	110	150	250	162
Hexatoma sp.	10					2
Mallochohelea sp.			30			6
Pagastia sp.	30	40		10	10	18
Rheotanytarsus sp.	20					4
Simulium sp.	30	200		90	100	84
TURBELLARIA		140	70	180	100	98
Dugesia sp.		140	70	180	100	98
MOLLUSCA						
GASTROPODA		20				4
Physa sp.		20				4
TOTAL (#/sq. meter)	1700	4210	1770	2720	4140	2908
NUMBER OF TAXA	19	12	17	15	18	28
SHANNON-WEAVER (H')	2.86	2.10	2.42	2.34	2.41	2.49
TOTAL EPT TAXA	11	7	9	7	9	13
EPT INDEX (% of Total Taxa)	58	58	53	47	50	46
EPHEMEROPTERA ABUNDANCE (% of Total Density)	36	47	56	50	35	44

MACROINVERTEBRATE DENSITY
SITE: COLUMBINE CREEK
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	510	240	390	160	150	290
Hesperoperla pacifica	40	10	30	40	10	26
Sweltsa sp.	350	120	210	90	40	162
Taenionema sp.	90	110	130	30	70	86
Zapada cinctipes	30		20		30	16
EPHEMEROPTERA	460	970	840	800	590	732
Baetis tricaudatus	170	330	210	260	200	234
Drunella coloradensis		10	20			6
Drunella doddsi	160	80	210	210	170	166
Epeorus deceptivus	10	30	50	20	20	26
Epeorus longimanus	10	40	10		30	18
Heptagenia elegantula		40	40	40		24
Rhithrogena hageni	110	440	300	270	140	252
Serratella micheneri					30	6
TRICHOPTERA	200	190	280	320	430	284
Arctopsyche grandis	10			10		4
Brachycentrus americanus					30	6
Cheumatopsyche sp.	50	50	110	90	190	98
Glossosoma sp.	10		20	40	90	32
Lepidostoma sp.		10				2
Micrasema bactro	10					2
Rhyacophila angelita/tucula		10				2
Rhyacophila brunnea/vao	10			10	10	6
Rhyacophila pellisa/valuma	110	120	150	170	110	132
COLEOPTERA	690	360	490	210	60	362
Heterlimnius corpulentus	690	360	490	210	60	362
DIPTERA	390	80	370	460	140	288
Chelifera/Metachela	80	10	50	100		48
Diamesa sp.		10				2
Dicranota sp.	30	10	20		10	14
Hemerodromia sp.					10	2
Heterotrissocladius sp.	150	20	100	40	40	70
Mallochohelea sp.	10		10	30	10	12
Pagastia sp.		10	90	10		22
Pericoma sp.	90	20	100	150	30	78
Rheotanytarsus sp.	30			130	40	40

MACROINVERTEBRATE DENSITY
SITE: COLUMBINE CREEK
SAMPLED: 9/15/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA		20	40	250	40	70
Eiseniella tetraedra			30		40	14
Unid. Immature Tubificidae w/o Capilliform Chaetae		20	10	250		56
NEMATODA	10		10			4
Unid. Nematoda	10		10			4
HYDARACARINA		10			20	6
Lebertia sp.		10			20	6
TOTAL (#/sq. meter)	2260	1870	2420	2200	1430	2036
NUMBER OF TAXA	23	23	24	21	24	35
SHANNON-WEAVER (H')	3.47	3.38	3.84	3.87	4.00	3.99
TOTAL EPT TAXA	15	14	14	13	15	21
EPT INDEX (% of Total Taxa)	65	61	58	62	63	60
EPHEMEROPTERA ABUNDANCE (% of Total Density)	20	52	35	36	41	36

MACROINVERTEBRATE DENSITY
SITE: CABRESTO CREEK
SAMPLED: 9/17/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1920	240	320	340	120	588
Capniidae				20		4
Cultus sp.	120	20	40	40	20	48
Hesperoperla pacifica	160				20	36
Isoperla sp.	80		20	40	20	32
Megarcys sp.	80	20				20
Perlomyia sp.	120	20	40	20	40	48
Sweltsa sp.	360	100	160	180	20	164
Taenionema sp.	40	80	60			36
Zapada cinctipes	960			40		200
EPHEMEROPTERA	8040	1560	1540	2700	1440	3056
Baetis tricaudatus	1560	380	320	800	280	668
Cinygmula sp.	40					8
Drunella doddsi	3600	700	660	1140	620	1344
Drunella grandis	80				20	20
Rhithrogena hageni	40		20	40	20	24
Seratella tibialis	2720	480	540	720	500	992
TRICHOPTERA	7040	1140	1400	1920	2540	2808
Arctopsyche grandis	1280	40	220	180	180	380
Brachycentrus americanus	40		60	20	40	32
Dolophilodes sp.	840			60	20	184
Glossosoma sp.	200	40	60	20		64
Lepidostoma sp.	1920	300	160	420	180	596
Oligophlebodes sp.	1080	640	600	960	1800	1016
Rhyacophila brunnea gr.	160				60	44
Rhyacophila rotunda gr.	240	20	20	40	40	72
Rhyacophila sibirica gr.	1280	100	280	220	220	420
COLEOPTERA	360	80	420	320	260	288
Cleptelmis sp.	40					8
Heterlimnius corpulentus	280	80	380	320	260	264
Narpus concolor	40		40			16
DIPTERA	8360	1340	1440	1700	760	2720
Chelifera/Metachela			20		20	8
Dicranota sp.	120		20		40	36
Heterotrissocladius sp.	1570	30	80	90	80	370
Hexatoma sp.	120			20		28
Mallochohelea sp.	360	60	260	80	80	168
Pagastia sp.	170		30	120	40	72
Pericoma sp.	3000	600	320	740	200	972
Protanyderus sp.			20			4
Rheotanytarsus sp.	3020	650	690	650	300	1062

MACROINVERTEBRATE DENSITY
SITE: CABRESTO CREEK
SAMPLED: 9/17/99

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
TURBELLARIA	160	20		80	80	68
Polycelis coronata	160	20		80	80	68
HYDRACARINA	40	20	80		20	32
Lebertia sp.		20	80		20	24
Sperchon/Sperchonopsis	40					8
MOLLUSCA						
GASTROPODA	40					8
Gyraulus sp.	40					8
PELECYPODA	80					16
Sphaerium sp.	80					16
TOTAL (#/sq. meter)	26040	4400	5200	7060	5220	9584
NUMBER OF TAXA	37	21	27	26	28	41
SHANNON-WEAVER (H')	4.07	3.47	3.98	3.75	3.50	4.06
TOTAL EPT TAXA	23	14	16	18	18	24
EPT INDEX (% of Total Taxa)	62	67	59	69	64	59
EPHEMEROPTERA ABUNDANCE (% of Total Density)	31	35	30	38	28	32